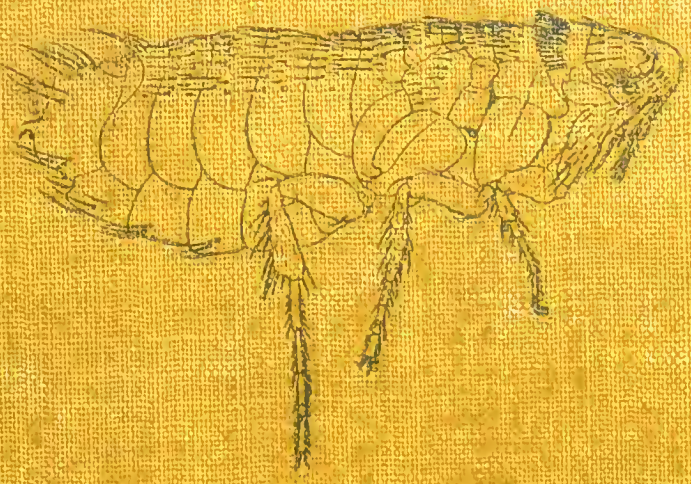

THE MINOR HORRORS OF WAR

Photograph of enlarged model of the house-fly (*Musca domestica*) in the American Museum of Natural History, New York. (From Gordon Hewitt.) P. 66.

[*Frontispiece*

THE MINOR HORRORS OF WAR

BY

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HENRICO ARTHURO ADEANE MALLET

ET

HENRICO ANTONIO PATRICIO DISNEY

ALTERI MARI AERE ALTERI

UTRIQUE FIDELISSIME

PATRIAM TUTANTI

PREFACE
TO
THE FIRST EDITION

The contents of this little book hardly justify its title. There are whole ranges of 'Minor Horrors of War' left untouched in the following chapters. The minor poets, the pamphlets of the professors, the people who write to the papers about 'Kultur' and think that this is the German for Matthew Arnold's over-worked word 'Culture,' the half-hysterical ladies who offer white feathers to youths whose hearts are breaking because medical officer after medical officer has refused them the desire of their young lives to serve their country. Surely, as Carlyle taught us, '*There is no animal so strange as man!*'

These 'Minor Horrors of War,' and many besides, have for the moment been neglected in favour of certain others which attack the bodies, the food, or the accoutrements of the men who are giving all that they have to

give, even unto their lives, for their homes and for their country.

I deal with certain little Invertebrata: animals which work in darkness and in stealth, little animals which in times of Peace we politely ignore, yet little animals which in times of War may make or unmake an army corps. As that wise old Greek, Aristotle, wrote—and he knew quite a lot about them—'*One should not be childishly contemptuous of the study of the most insignificant animal. For there is something marvellous in all natural objects.*'

We are shy of mentioning these organisms in times of Peace; but all of them are within the cognisance of every medical officer of health and of every police-court missionary. These gentlemen do not talk about them in general society: the subject is as a rule 'taboo.' Yet if we face these troubles with courage and frankness, they can be overcome. As 'Emigration Jane' says: '*Well, there's nothink lower than Nature, an' She Goes as 'Igh as 'Eaven.*'

I confess that these articles have been written in a certain spirit of gaiety. This is the reflex of the spirit of those who have gone to the Front and of my fellow countrymen in general. For more years than I care to remember, the spirit of Great Britain and of Ireland had

been sombre, self-distrusting—we were till half a year ago far too '*conscious of each other's infirmities*'; but with the outbreak of the War everything changed. Our nearest relatives, our dearest friends, are dead, or dying, or wounded, or prisoners; but we at home at once caught the spirit of those who have died or have suffered for us abroad, and we have kept and still keep a high heart. As Mrs. Aberdeen, the immortal 'bedmaker' at King's College, Cambridge, said: *But surely, Miss, the world being what it is, the longer one is able to laugh in it, the better.*' Mrs. Aberdeen spoke in times of Peace; but I feel that that indomitable old lady would have said the same in times of War.

These chapters first appeared in the columns of the *British Medical Journal*. I very gratefully thank the editor and the proprietors of that Journal for their permission to reprint them.

A. E. SHIPLEY.

Christ's College Lodge, Cambridge.
February 14, 1915.

PREFACE
TO
THE SECOND EDITION

ALTHOUGH this little book was only issued on March 23, 1915, and although greatly daring the publishers issued a very large edition, it soon passed out of print.

In preparing a second edition, I have to thank many kind correspondents for help, especially in the matter of varying methods of freeing our Army from lice. Many of these suggestions I have incorporated; but I must once more warn my readers that I am no physician, and cannot testify from personal experience to the value of the several remedies that have been so kindly sent to me.

A. E. SHIPLEY.

CHRIST'S COLLEGE LODGE, CAMBRIDGE.
April 23, 1915.

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THE
MINOR HORRORS OF WAR

CHAPTER I

THE LOUSE (*Pediculus*)

Care'll kill a cat, up-tailles all and a louse for the hangman !
(B. Jonson, *Every Man in his Humour.*)

Lice form a small group of insects known as the *Anoplura*, interesting to the entomologist because they are now entirely wingless, though it is believed that their ancestry were winged. They are all parasites on vertebrates. In quite recent books the *Anoplura* are described as 'lice or disgusting insects, about which little is known,' but lately, owing to researches carried on at Cambridge, we have found out something about their habits. As lice play a large part in the minor discomforts of an army, it is worth while considering for a moment what we know about them.

Recently, the group has been split up into a large number of genera, but of these

only two have any relation to the human body. I do not propose, in the present chapter, to consider one of these two genera—*Phthirius*—which frequents the hairs about the pubic region of man and is conveyed from one human being to another by personal contact. We will confine our attention to the second genus, *Pediculus*, which contains two species parasitic upon man—(*Pediculus capitis*) the hair-louse and (*Pediculus vestimenti*) the body-louse. Both of these are extremely difficult to rear in captivity, though in their natural state they abound and multiply to an amazing degree.

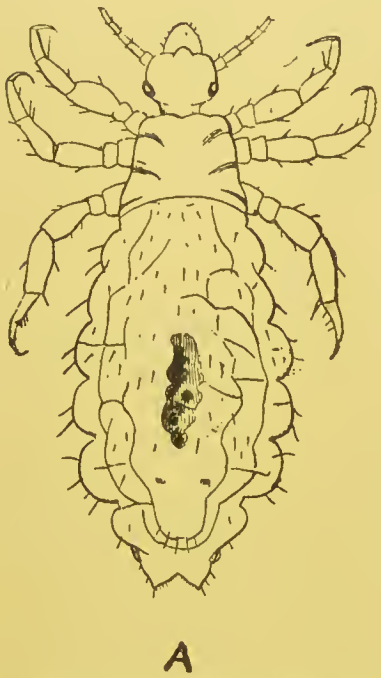


FIG. 1.—*Pediculus vestimenti* (Nitzsch). A, Magnified 20 times; B, natural size.

Wherever human beings are gathered together in large numbers, with infrequent opportunities of changing their clothes, *P. vestimenti* is sure to spread. It does not

arise, as the uninformed think, from dirt, though it flourishes best in dirty surroundings. No specimen of *P. vestimenti* exists which is not the direct product of an egg laid by a mother-louse and fertilised by a father-louse. In considerable collections of men drawn from the poorer classes, some unhappy being or other—often through no fault of his own—will turn up in the community with lice on him, and these swiftly spread to others in a manner that will be indicated later in this chapter.

Like almost all animals lower than the mammals, the male of the body-louse is smaller and feebler than the female. The former attains a length of about 3 mm., and is about 1 mm. broad. The female is about 3·3 mm. long and about 1·4 mm. broad. It is rather bigger than the hair-louse, and its antennae are slightly longer. It so far flatters its host as to imitate the colour of the skin upon which it lives; and Andrew Murray gives a series of gradations between the black louse of the West African and Australian native, the dark and smoky louse of the Hindu, the orange of the Africander and of the Hottentot, the yellowish-brown of the Japanese and Chinese, the dark-brown of the North and South American Indians, and the paler-brown of the Esquimo, which approaches the light

dirty-grey colour of the European parasites.

> As plump an' grey as onie grozet,

as Burns has it.

The latter were the forms dealt with in the recent observations undertaken by Mr. C. Warburton in the Quick Laboratory at Cambridge, at the request of the Local Government Board, the authorities of which were anxious to find out whether the flock used in making cheap bedding was instrumental in distributing vermin. Mr. Warburton at once appreciated the fact that he must know the life-history of the insect before he could successfully attack the problem put before him. At an early stage of his investigations, he found that *P. vestimenti* survives longer under adverse conditions than *P. capitis*, the head-louse.

The habitat of the body-louse is that side of the under-clothing which is in contact with the body. The louse, which sucks the blood of its host at least twice a day, is when feeding always anchored to the inside of the under-clothing of its host by the claws of one or more of its six legs. Free lice are rarely found on the skin in western Europeans; but doctors who have recently returned from Serbia report dark-brown patches, as big as half-crowns, on the skins of the wounded natives, which on touching begin to move—a

clotted scab of lice! But the under-side of a stripped shirt is often alive with them.

After a great many experiments, Mr. Warburton succeeded in rearing these delicate insects, but only under certain circumscribed conditions: one of which was their anchorage in some sort of flannel or cloth, and the second was proximity to the human skin. He anchored his specimens on small pieces of cloth which he interned in small test-tubes plugged with cotton-wool, which did not let the lice out, but did let air and the emanations of the human body in. For fear of breakage the glass tube was enclosed in an outer metal tube, and the whole was kept both night and day near the body. Two meals a day were necessary to keep the lice alive. When feeding, the pieces of cloth, which the lice would never let go of, were placed on the back of the hand, hence the danger of escape was practically *nil*, and once given access to the skin the lice fed immediately and greedily.

His success in keeping lice alive was but the final result of many experiments, the majority of which had failed. Lice are very difficult to rear. When you want them to live they die, and when you want them to die they live, and multiply exceedingly. A single female but recently matured was placed in a test-tube, and a male admitted to her on the second day.

The two paired on the sixth day and afterwards

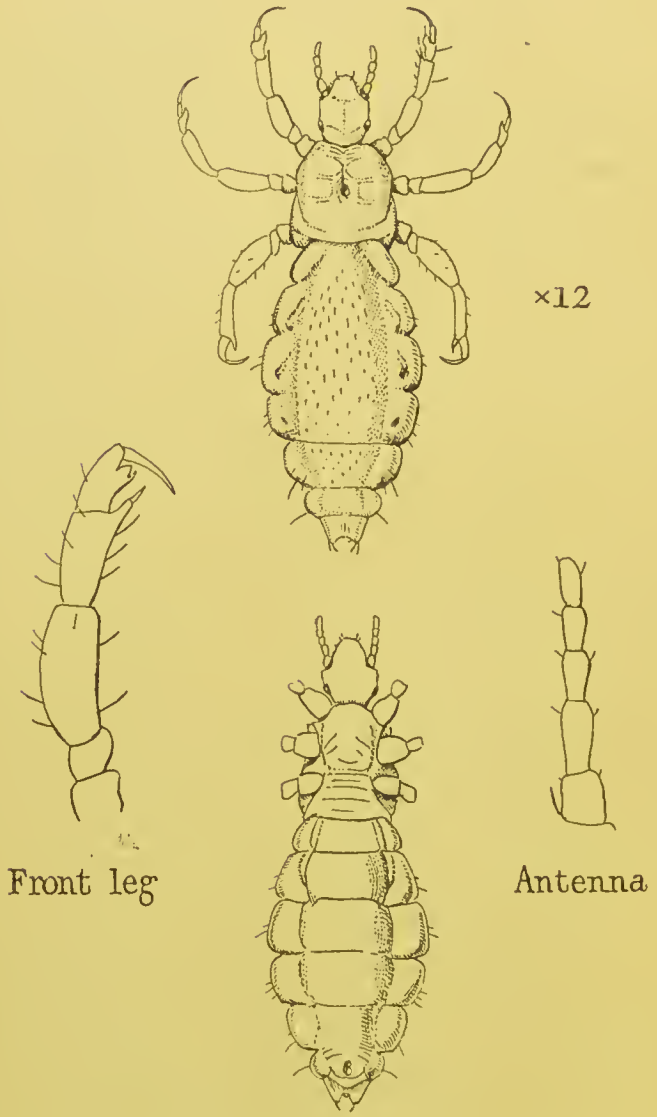


Fig. 2.—*Pediculus vestimenti.* Dorsal and ventral views.

at frequent intervals. Very soon after pairing

an egg was laid, and during the remaining twenty-five days of her life the female laid an average of five eggs every twenty-four hours. The male died on the seventeenth day, and a second male was then introduced, who again paired with the female. The latter, however, died on the thirtieth day, but the second male survived.

The difficulty of keeping the male and female alive was simple compared with the difficulty of rearing the eggs. Very few hatched out. The strands of cloth upon which they were laid had been carefully removed and placed in separate tubes, at the same time being subjected to different temperatures. It was not, however, until the eggs were left alone undisturbed in the position where they had been laid and placed under the same conditions that the mother lived in that eight, and only eight, of the twenty-four eggs laid on the cloth hatched out after an incubation period of eight days. The remaining sixteen eggs were apparently dead. But the tube in which they were was then subjected to normal temperature of the room at night (on occasions this fell below freezing-point), and after an incubation period of upwards of a month six more hatched out. Hence it is obvious that, as in the case of many other insects, temperature plays a large part in the rate of development, and it

becomes clear that the eggs or nits of *P. vestimenti* are capable of hatching out up to a period of at least from thirty-five to forty days after they are laid.

Difficult as it was to keep the adults alive, and more difficult as it was to hatch out the eggs, it was most difficult to rear the larvae. Their small size made them difficult to observe, and, like most young animals, they are intolerant of control, apt to wander and explore, and less given to clinging to the cloth than their more sedentary parents. Naturally, they want to scatter, spread themselves, and pair.

Like young chickens, the larvae feed immediately on emerging from the egg. They apparently moult three times, at intervals of about four days, and on the eleventh day attain their mature form, though they do not pair until four or five days later.

Mr. Warburton summarises the life-cycle of the insects, as indicated by his experiments, as follows :—

Incubation period : eight days to five weeks.
From larva to imago : eleven days.
Non-functional mature condition : four days.
Adult life : male, three weeks ; female, four weeks.

But we must not forget that these figures are based upon laboratory experiments, and that under the normal conditions the rate may be accelerated. From Mr. Warburton's experience it is perfectly obvious that, unless

regularly fed, body-lice very quickly die. Of all the verminous clothing sent to the Quick Laboratory, very little contained *live* vermin. The newly hatched larvae perish in a day and a half unless they can obtain food. These facts regarding the life-history of body-lice were fully confirmed by Dr. Fantham when working on the protozoal parasites of lice.

With regard to the head-louse :—

> Ye ugly, creepin', blastit wonner,
> Detested, shunn'd by saunt an' sinner,

it is smaller than the body-louse, and is of a cindery grey colour. The female measures 1·8 mm. in length and 0·7 in breadth. Like the body-louse, it varies its colour somewhat with the colour of the hair on the different branches of the human race. It lives amongst the hair of the head of people who neglect their heads ; it is also, but more rarely, found amongst the eyelashes and in the beard. The egg, which has a certain beauty of symmetry, is cemented to the hair, and at the end of six days the larvae emerge, which, after a certain number of moults, become mature on the eighteenth day. The methods adopted by many natives of plastering their hair with coloured clay, or of anointing it with ointments, probably guards against the presence of these parasites. The Spartan youths, who used to oil their long locks before

going into battle, may have feared this parasite. Some German soldiers, before going to war, shave their heads: thus they afford no nidus for *P. capitis*. The wigs worn in the late seventeenth and at the beginning of the eighteenth centuries undoubtedly owed something to the difficulty of keeping this particular kind of vermin down. The later powdering of the hair may have been due to the same cause.

This book, however, attempts to deal more with the troubles of the camp, and *P. capitis* is in war time less important than *P. vestimenti*. The former certainly causes a certain skin trouble, but the latter not only affords constant irritation, but, like most biting insects, from time to time conveys most serious diseases. *P. vestimenti* is known to be the carrier of typhus. This was, I believe, first demonstrated in Algeria, but was amply confirmed last year in Ireland, when a serious outbreak of this fever took place, though little was heard of it in England. Possibly, *P. capitis* also conveys typhus, but undoubtedly both convey *Spirochaeta recurrentis*—the cause of relapsing or recurrent fever. The irritation due to the body-louse weakens the host and prevents sleep, besides which there is a certain psychic disgust which causes many officers to fear lice more than they fear bullets. Also by rubbing or scratching the lice may be

crushed on the skin. The germs of disease within them may thus be inoculated directly into the blood through the surface of the skin damaged by the scratch. Soldiers should, further, always avoid touching their eyes after scratching insect-bites. Lice are the constant accompaniment of all armies; and in the South African War as soon as a regiment halted they stripped to the skin, turned their clothes inside out, and picked the *Anoplura* off. As a private said to me: 'We strips and we picks 'em off and places 'em in the sun, and it kind o' breaks the little beggars' 'earts!'

There were serious outbreaks of typhus during the recent Balkan Wars among the combatants, prisoners, and refugees. The epidemics were spread by lice. Again, typhus and relapsing fever are endemic in various areas along the eastern front of the present theatre of war, and is now raging in Serbia. Owing to the frequent changing of men from one front to another on the part of the enemy, there is risk of spread of infection among the various armies engaged. In conjunction with the Quick Professor of Biology at Cambridge, I have drawn up the following rules. None of them will be possible at all times, but some of them may be possible at some time in the campaign. At any rate, by acting on these rules, a relative of mine who took part in the South African War was able to escape the presence of lice

on his body, and the General commanding his brigade told me on his return that he was the only officer—and in fact the only man—in the brigade who had so escaped.

How the Soldier may Guard Himself against Infestation with Lice

In times of war, when men are aggregated in large numbers and personal cleanliness—but especially an adequate change of clothing—cannot be secured, infestation with lice commonly takes place. The prevalence of lice in troops in the South African War was a source of serious trouble in that their attacks caused much irritation to the skin and disturbed men's sleep.

Lice occur chiefly on the body (*Pediculus vestimenti*) and head (*P. capitis*). They are small greyish-white insects. The female lays about sixty eggs during two weeks; the eggs hatch after nine to ten days. The lice are small at first; they undergo several moults and grow in size, sucking blood every few hours, and attain sexual maturity in about two weeks. The eggs will not develop unless maintained at a temperature of 22° C. or over—such as prevails in clothing worn on the human body or in the hair of the head. This is why, *when clothing is worn continuously*, men are more prone to become infested with lice derived from habitually unclean persons, their clothing,

bedding, &c. *P. capitis* lives between the hair in the head, and the eggs, called 'nits,' are attached to the hairs. *P. vestimenti* lives in the clothing, to which it usually remains attached when feeding on man; it lays its eggs in the clothing, and usually retreats into the seams and permanent folds therein. This is of importance in considering the means of destroying lice.

To avoid these pests the following rules should be observed:—

1. Search your personas often as possible for signs of the presence of lice—that is, their bites. As soon as these are found, lose no time in taking the measures noted under paragraph 5.

2. Try not to sleep where others, especially the unclean, have slept before. Consider this in choosing a camping-ground.

3. Change your clothing as often as practicable. After clothes have been discarded for a week the lice are usually dead of starvation. Change clothes at night if possible, and place your clothing away from that of others. Jolting of carts in transport aids in spreading the lice, which also become disseminated by crawling about from one kit to another. Infested clothing and blankets, until dealt with, should be kept apart as far as possible.

4. Verminous clothes for which there is no further use should be burnt, buried, or sunk in water.

5. If lice are found on the person, they may be *readily destroyed by the application of either petrol, paraffin oil, turpentine, xylol, or benzine.* Apply these to the head in the case of *P. capitis.* Remember that these fluids are all **highly inflammable.** When possible, soap and wash the head twenty-four hours after the last application of petrol, &c. The application may be repeated on two or more days if the infestation is heavy. Fine combs are useful in detecting and removing vermin from the head. Tobacco extract has been advocated failing other available remedies. In the case of *P. vestimenti*, the lice can be killed as follows: Under-clothes may be scalded—say, once in ten days. Turn coats, waistcoats, trousers, &c., *inside out*; examine beneath the folds at the seams and expose these places to as much heat as can be borne before a fire, against a boiler, or allow a jet of steam from a kettle or boiler to travel along the seams. The clothing will soon dry. If available, a hot flat-iron, or any piece of heated metal, may be used to kill vermin in clothing. Petrol or paraffin will also kill nits and lice in clothing. If no other means are available, turn the clothing inside out, beat it vigorously, remove and kill the vermin by hand—this will, at any rate, mitigate the evil.

6. As far as possible avoid scratching the irritated part.

7. Privates would benefit by instruction in these matters.

8. Apart from the physical discomfort and loss of sleep caused by the attacks of lice, it should be noted that they have been shown to be the carriers of typhus and relapsing fever from infected to healthy persons. Typhus, especially, has played havoc in the past, and has been a dread accompaniment of war.

Dr. R. J. Drummond has drawn my attention to a common folklore belief emplanted in the minds of our poorer people. Incredible as it seems, these uneducated and ignorant folk believe that lice on the person is a sign of productivity, and that should they be removed their hosts will become barren or sterile. They transfer, by a process of sympathetic magic, the productivity of the lice to the lousy. As Dr. Drummond writes, these ignorant mothers and aunts believe that the nits and the lice arise spontaneously, and are 'an outward and visible sign of an inward and invisible fertility.' Those who try to cleanse the heads and the bodies of our primary schoolchildren are 'up against' the superstitions of the little ones' guardians, and these guardians unfortunately often prove the stronger. Similar views are held widely by the various peoples of India and the East—people we call heathen

—and, apart from the connexion thought to be established between fertility and lice, the presence of the latter is considered both at home and abroad to be a sign of robust health.

The rather obscure connexion of the louse and the pike (*Esox lucius*) is probably due to the fact that the Latin name for the pike is *Lucius*. The poor pun in 'The Merry Wives of Windsor' on the Lucy family is due to a similar resemblance in sound.

The Editor of the *Morning Post* has given me leave to quote the following paragraphs from an article by his able Correspondent at Petrograd.

All armies, after a few weeks' campaigning, whatever other hardships may come their way, are sure of one—namely, certain parasites. Even officers under most favourable conditions are unable to keep clear of this scourge. Silk under-clothing is some palliative, but no real preventative. Various measures have been proposed to relieve the intense annoyance caused by millions of parasites of at least two species. Flowers of sulphur, worn in bags round the neck, were supposed to be a preventative, but proved fallacious.[1] What seems likely to prove perfect prophylactery is recommended by M. Agronom, who writes from Bokhara, where he has noted the habits of the Sarts and their preventative measures.

The Sarts never wash, and hardly ever in lifetime change their clothes; therefore their condition

[1] But see p. 18. Some most experienced medical officers have found sulphur very effective; others deny its value.

would be impossible without some preventative measures. They take a small quantity of mercury, which they bray into an amalgam with a plant used in the East for dyeing the hair and nails—probably henna. This paste is evenly laid on strands of flax or other fibres. One string thus prepared is worn round the neck and the other round the waist next the skin, the heat of the body producing exhalations which kill parasites. The string lasts quite a long time.

M. Agronom has made experiments with the ordinary mercurial ointment prepared with any kind of fat, and finds the effect precisely the same. He asserts that such a minute quantity of mercury as is required to produce the desired result is perfectly harmless to the system. A half-crown's worth of mercury brayed in a mortar with lard or other fat will suffice to treat enough threads for several hundred soldiers. The threads should be of ten or a dozen strands or some very loosely twisted material like worsted, and should be wrapped in parchment paper before boxing for dispatch to the soldiers. This is effective and lasting for body parasites. Others are easily dealt with by rubbing in petroleum, which must be done twice at a week's interval.

It should also be noted that no ordinary washing methods will clear the parasites from body-linen even when dipped in boiling water; but if a couple of spoonfuls of petroleum are added to every gallon of water, perfect success is assured even without boiling.

I confess I think he is a little bit too dogmatic about the habits of the Sarts. I am told the better-class Sarts do occasionally bathe, or why are there public baths at Khiva?

After all, in our oldest and most cultured University, only a year ago, the venerable Head of a House exclaimed with some acerbity, when a junior Fellow suggested putting up hot-water baths for the undergraduates: 'Baths! why the young men are only up eight weeks!'

And, again, though the clothes of the Sarts are doubtless flowing, unless they are elastic, they must get bigger as babyhood passes to boyhood and boyhood passes to manhood.

Preparations of mercury are also used in India: not only against human lice, but against the Mallophaga or biting-lice which infest the Indian birds used in falconry. It is difficult for a zoologist to believe the last paragraph of the *Morning Post* correspondent. The temperature of boiling water coagulates animal protoplasm as it does that of the white-of-egg; and what would the louses do then, poor things?

Early in the year, Mr. C. P. Lounsbury, the well-known Government Entomologist in South Africa, wrote that they were supplying the troops there with sulphur-bags which were supposed to keep the lice away. The sulphur is put in small bags of thin calico, and several of these are secured on the under-clothing, next to the skin. The bags are about two inches square, and I am told that it is customary to have one worn on the trunk of the body and one against each of the nether limbs. Whether this is effective will probably be known soon;

but that flowers of sulphur do play an effective part in keeping down these troubles is shown by a letter of Dr. Harding H. Tomkins :—

Over thirty years ago, when house-surgeon at the Children's Infirmary, Liverpool, I used this with absolute success in all cases of plaster-of-Paris jackets who formerly had been much distressed by vermin getting under the jacket. The sulphur was rubbed well into the under-clothes.

But still more interesting evidence is given by Dr. N. Bishop Harman :—

When I was serving in the South African War, and attached to No. 2 General Hospital at Pretoria, I was detailed to take medical charge of the camp of released prisoners that was established a few miles out of the town on the Delagoa Bay railway line. I moved into the camp the night they came in. Next day an inspection was held. I do not think I ever saw such a sorry sight. The men were in the most nondescript garments, and they were flabby from the effects of the food the Boers had given them—mealy pap, for the most part. They had had no washing facilities, and they were dirty in the extreme. Amongst them were a number of men of the D.C.O. Yeomanry, many of them Cambridge men, and when these came to me for special examination, unwarily I invited them into my tent to strip, and their clothes were laid on the only available support—my bed. The next day or two was spent in cleaning up the men and refitting them. By the end of the week I noticed in the evening an unpleasant itch about the lower part of the trunk : a sub-acute sort of itch, it did not seem

like a flea, and I could find nothing. But after a most diligent search with all the candles I could borrow, I found, to my horror, a louse. It was a genuine body-louse. Then I remembered my folly in inviting strangers into my tent. Water was scarce, the morning tub was only the splash from a can. Laundry was impossible. But after some trouble I managed to get a can of hot water and get some sort of a hot wash. My man did the best he could with my shirt and pants. What to do with the bedding—dark brown blankets—I did not know, except to expose them to the hot sunshine. I rode into the town, but insect-powder could not be got. It came into my mind that I had read or heard that people who took sulphur-tablets smelled of H_2S, so on the chance that an outside application might be of some service I got a supply of flowers of sulphur. This I liberally sprinkled all over my clothes, bedding, and rubbed into the seams of my tunic and riding-breeches. The itching was stopped in a day, and it never came again. But I soon noticed another circumstance: all the bright brass buttons of my tunic, although freshly polished by my man every morning, were tarnished before evening, even in the clean, dry atmosphere of the dry veld. Also my silver watch-case went black. There was no doubt that the sulphur was acted upon by the secretions of the skin and H_2S was produced, and this I had no doubt killed off any lice that could not be got at by washing. Subsequently, I always used it when I was in likely places. And some places were very likely! In Cape Town, I had to inspect all the soldiers' lodgings in view of the spread of the plague. And, again, I had charge of a Boer prison-ship, and never once did I catch so much as

a hopper. The prison-ship was literally alive with cockroaches of all sizes; our cabins swarmed with them, but they avoided my clothes and kit like a plague, and there was never a nibble-mark to be found. I gave the hint to many men and they confirmed my experience. I have since met other men who hit on the same device with equal success. In this war I have told the tip to many friends, and some relatives, who have gone out, and so far they have been free from the plague. You will note that I used all the other measures I could, but my bedding and uniform were not washed, and the lice must have come through the bedding; there was no other possible means I could trace. Yet the flowers of sulphur killed off all that might be therein.

It is by no means unusual to find on the mummified bodies of the ancient Egyptians little bags of silk, in the interstices of which fragments of sulphur are tucked away. As is well known, lice was one of the plagues of Egypt, and it seems extremely probable that these little sulphur 'amulets' were really worn as a protection against these insect pests. This view is confirmed by Dr. H. C. Martin of Exmouth, who points out that such sulphur-bags were worn by the Italian soldiers in Tripoli and are now worn by the French soldiers in the present war.

Dr. W. A. Jamieson of Edinburgh, who has written on the symptoms caused by the presence of lice and generally on the medical

aspect of this pest, also recommends, as an effective cure, the wearing of pieces of sulphur in canvas bags, next the skin, night and day.[1]

The exact action of the sulphur does not seem to be thoroughly understood; but in contact with the fatty substances in the sweat it is quite probable that it would undergo reduction with the formation of small quantities of H_2S. If there are any fermentative changes going on in sweat, such a reduction would be highly probable. Sulphur reacts readily with organic substances at high temperature. H_2S can be produced on a large scale by heating a mixture of sulphur and vaseline; and a solution of sulphur in oil of turpentine evolves H_2S on heating. Possibly the same sort of thing may go on, under favourable conditions, slowly at lower temperatures. It is possible also that SO_2 is formed and sulphuric acid, by the action of air on moist sulphur in small quantities; but it seems improbable that the SO_2 is anything like so toxic as the H_2S, and the small quantities of SO_2 formed in this manner would be unlikely to affect the lice. It is obvious that there is some room here for experiment.

A very effective method for exterminating vermin in infected troops was carried out by Dr.

[1] *Brit. Journ. Dermatology*, vol. l., 1889, p. 321; and vol. vii., 1895, p. 248.

S. Monckton Copeman, F.R.S., at Crowborough. To put the matter briefly, I append a copy of his able and concise memorandum which was distributed to all the medical officers of the Division; but further details may be obtained by referring to the *British Medical Journal*, or the *Lancet* of February 6, 1915.

To the Medical Officer . . . . . .

Treatment for Destruction of Vermin.

Arrangements should be made for the bathing of affected individuals and other inmates of infected tents.

After drying themselves, men to lather their bodies with cresol-soap solution (water 10 galls., Jeyes' fluid 1½ oz., soft soap 1½ lb.), especially over hairy parts, and to allow the lather to dry on.

Shirts to be washed in cresol-soap solution made with boiling water.

Tunics and trousers to be turned inside out, and rubbed with same lather, especially along the seams. Lather to be allowed to dry on the garment.

The materials can be obtained from the A.S.C. on indent authorised by A.D.M.S. in the form attached.

Infected blankets were at first treated by soaking them in cresol-soap solution, after which they were sent to a neighbouring laundry to be washed—a small contract rate having previously arranged. In the first week in November, however, a portable Thresh's steam disinfecting apparatus was supplied to the Division, through the Second Army, since when no difficulty has been experienced in the disinfection both of clothing and blankets.

As a matter of fact the simple and inexpensive method which has been employed by us over a period of several months has proved so successful that no necessity has arisen for a trial of any other means of treatment.

Since the issue of the first edition of this little book many experienced medical men have sent me the best cures they have arrived at in dealing with these deadly pests: these I now publish. None will be universally applicable, but some may be applicable here and others there.

Captain H. E. Sutherland Richards, Medical Officer 1st West Lancs. R.F.A., recommends :—

. . . Bathing in hot bath, into which one of the coal-tar preparations, containing cresolic acids—like Jeyes' fluid or Liquor cresolis saponatus, has been pounded. In cases of recent infection this method gave good results ; but in obstinate cases, . . . which I attributed to the hatching-out of fresh crops of *Pediculi* from the ova firmly cementcd on to the pubic and axillary hairs, . . . complcte removal of all hairs has removed the ' nidus ' of the pest.

The application of petrol or paraffin, although having some solvent action on the keratinous sort of cement attaching the ova to the hair, cannot have as thorough an effect as a complete removal of the breeding-ground of the pest itself. . . .

Dr. Paul M. Chapman, F.R.C.P.(Lond.), recommends :—

Oleate of mercury 10 per cent., methylated ether

in equal parts. Dip a comb into the preparation and apply to the hair.

Lice in clothes should be dealt with as follows: Perchloride of mercury, 5 per cent. solution, should be applied lightly to the skin and rubbed into creases of the clothing.

Dr. W. B. Hunter, of Londonderry, writes that—

years ago he found the application of hydrocyanic acid, in a diluted form, was very effective in ridding the human body, and the human clothes, of all three species of louse.

Dr. J. Cryer recommends that—

when suffering from *Pediculus vestimenti* and *P. capitis* get a penny packet of chloride of lime, take a *hot* bath, and while in the bath make a hole in each end of the packet, wash the lime out, and lie soaking in it for five minutes; the effect is marvellous.

Lieut. A. G. Levy, R.A.M.C. (T.), states :—

Garments can be disinfected from *P. Vestimenti* by spraying with perchloride of mercury solution (1 in 1000) quite satisfactorily. This method has obvious advantages, for the garments are not soaked, and they dry quickly on being hung up. With a sufficiently powerful spray bad cases might be treated wholesale.

Surgeon-Major F. F. MacCabe writes :—

I have found a preparation called *Leucoid*, which is a disinfectant made with a solid and non-greasy base, . . . to be the most satisfactory means of removing lice from the body of man or animals.

The directions for use are: 'Take a warm bath and rub a lump of damp leucoid over the surface of the body, washing it *particularly into the hairy parts*.' This kills all lice and their eggs, and leaves the skin free from all germs and dirt. It washes off like soap when water is poured on it. It may be applied to the broken skin, as although it stings it makes the scratched parts heal up at once, and the users are delighted with it. . . . Our squadron out in France has used this with the best results. The preparation is only of course some disinfectant with a basis of haolin and glycerine, but it must be supplied and left in its original aluminium box, as it both absorbs water and gives off volatile disinfectants if not left in a closed container. I have found it gets men clean when even after all other means had been tried they were said to 'breed lice.'

Dr. George Pernet deals with *Pediculus Vestimenti*, as follows :—

1. All body- and bed-linen and clothes should be baked or sterilised by boiling.

2. *Unguentum staphisagriae* should be applied to neck-bands of vests and shirt in the region of the neck.

3. Alkaline baths to soothe the irritated skin.

Flowers of sulphur sprinkled in the bed and in the clothes are very useful.

Dr. T. H. Moorhead, of Errigle, Cootehill, Ireland, writes that—

at the time of the last outbreak of typhus here, it was stated in one of the daily papers that travelling circus and similar companies, who have to take whatever lodgings they can get, protect themselves with sulphur. I put it into use at once with the

most satisfactory results, I and my staff both took it internally and dusted our clothes with it. Dusted on verminous clothes . . . it seemed to banish the vermin at once, and by occasional treatment afterwards for experiment the clothes were quite freed from vermin. . . . I used to dread these typhus outbreaks, but I have ceased to do so since I saw the effects of sulphur.

Dr. Andrew Balfour, of the Wellcome Bureau of Scientific Research, writes :—

Captain Sibley, R.A.M.C., has told me about Major Lelean's new method for dealing with lice. A two-inch loose-woven bandage is made into a tubular bag. Into this bag two teaspoonfuls of the following powder is poured and evenly distributed :—

Naphthalene . . .	96 per cent.
Iodoform	2 ,,
Creasote	2 ,,

The bag is then tied round the waist, and it is said that all lice are killed within twenty-four hours.

Professor Pope tells me that—

if the active agent in the flowers of sulphur, in killing vermin, be the hydrogen sulphide produced, better and quicker results might be obtained by using some substance which yields the gas more rapidly. Some inert powdered matter—chalk or fine sand—rubbed up with a small proportion, say, one per cent. at most, of liver of sulphur, might be used. Liver of sulphur is potassium bisulphide, which, with atmospheric moisture and carbon dioxide, gives calcium carbonate and hydrogen sulphide.

Dr. F. E. Batten and Surgeon H. Whichello recommend oil of sassafras, extracted from the American tree, *Sassafras officinale* (*Laurus sassafras*) for *P. capitis*. Miss Macdonald, a sister at the Hospital for Sick Children, Great Ormond Street—and, after all, in these matters, the sisters and the nurses usually know more than the mere male—tells me that they—

use oil of sassafras almost always. It is applied to the scalp with a swab of wool, rubbed into the partings all over the head; then the hair is gathered up into a butter-muslin cap, which is secured tightly by bringing the ends round the head and tied on the top. This treatment should be done at night time, and then in the morning, when the patient is washed, the hair should be well washed with soap and water.

Miss Jane Gilmore-Cox recommends for *P. capitis* :—

Carbolic acid, 1 part in 40 parts of olive oil. The head must be soaked for at least three days and three nights with the carbolic oil, and then washed, when it will be found that even the nits are killed.

Dr. George Pernet suggests for *P. capitis* :—

1. Prevention: hair to be kept close cropped and clean.

2. For the nits: wipe them off with a solution of 1 in 30 carbolic acid.

3. For the lice themselves: Unguentum hydrargyri ammoniati dil. (gr. x ad ʒj), or any fatty, sticky body

well rubbed into the back of the head. Paraffin lamp-oil (kerosene) also good, but not to be used near a naked flame or light.

Professor Lefroy, of the Royal College of Science and Technology, recommends two effective remedies, known respectively as 'Vermijelli' and 'Vermin Westropol.'[1] Lieut.-Colonel E. J. Cross has successfully treated the clothes and bedding of his men with a powder consisting of three parts of black hellebore-root[2] and one of borax, and many similar powders are produced by the manufacturers of insecticides.

Let us end up this chapter cheerfully!

Theodore Hook having offended the third Lady Holland, at Holland House, that lady, with more vigour than delicacy, turned him out of the house, and told him 'she did not care three skips of a louse for him.' Hook in revenge addressed to her the following lines:—

> Her ladyship said when I went to her house
> She did not regard me three skips of a louse.
> I freely forgave what the dear creature said,
> For ladies will talk of what runs in their head.

[1] *B.M.J.* No. 2824, Feb. 13, 1915.

[2] Dr. J. J. H. Holt tells me this is the black hellebore, *Helleborus officinalis niger*, the Christmas rose.

CHAPTER II

THE BED-BUG (*Cimex lectularius*)

In 'x' finita tria sunt animalia dira;
Sunt pulices fortes, cimices, culicumque cohortes;
Sed pulices saltu fugiunt, culicesque volatu,
Et cimices pravi nequeunt foetore necari.

(Anon.)

Among the numerous disagreeable features of the bed-bug is the fact that it has at least two scientific names—*Cimex* (under which name it was known to the classical writers) and *Acanthia*. The latter name is favoured by French and some German authorities, but *Cimex* was the name adopted by Linnaeus, and is mostly used by British writers, and will be used throughout this article. One cannot do better than take the advice of that wise old entomologist, Dr. David Sharp, and allow the name '*Acanthia* to fall into disuse.'

The species which is the best known in England is *C. lectularius*; but there is a second species which is much commoner in warm climates, *C. rotundatus*. As regards carrying disease, this latter species is even more

dangerous than its more temperate relative. Other species, which rarely if ever attack man, are found in pigeon-houses and dove-cotes, martins' nests, poultry-houses, and the homes of bats.

FIG. 3.—*Cimex lectularius*, male. × 15. (From Brumpt.)

The common bed-bug seems to have arrived in England about the same time as the cockroach—that is, over four hundred years ago, early in King Henry VIII's reign. Apparently, it came from the East, and was for many years confined to seaports and harbours. It seems to have been first mentioned by playwriters

towards the beginning of the seventeenth century. The sixteenth-century dramatists could never have resisted mentioning the bug had it been in their time a common household pest. It would have appealed to their sense of humour.

How the insect got the name of 'bug' is unknown. It has been suggested that the Old English word 'bug,' meaning a ghost or phantom which walked by night, has been transferred to *Cimex*. This may be so, but the 'Oxford English Dictionary' tells us that proof is lacking.

The insect is some 5 mm. in length and about 3 mm. in breadth, and is of a reddish- or brownish-rusty colour, fading into black. Its body is extraordinarily flattened, so that it can readily pass into chinks or between splits in furniture and boarding, and this it does whenever daylight appears, for the bug loves darkness rather than light. The head is large, and ends in a long, piercing, four-jointed proboscis, which forms a tube with four piercing stylets in it. As a rule the proboscis is folded back into a groove, which reaches to the first pair of legs on the under surface of the thorax. This folding back of the proboscis gives the insect a demure and even a devout expression: it appears to be engaged in prayer, but a bug never prays. The head bears two black eyes

and two four-jointed antennae. Each of the six legs is provided with two claws, and all the body is covered with fairly numerous hairs. The abdomen shows seven visible segments and a terminal piece.

The bug has no fixed period of the year for breeding; as long as the temperature is favourable and the food abundant, generation will succeed generation without pause. Should, however, the weather turn cold the insects become numbed and their vitality and power of reproduction are interrupted until a sufficient degree of warmth returns.

Like the cockroach, the bed-bug is a frequenter of human habitations, but only of such as have reached a certain stage of comfort. It is said to be comparatively rare in the homes of savages, but it is only too common in the poorer quarters of our great cities. The iron bedstead which has so rapidly replaced the wooden bedstead was at one time thought to render the bug's position untenable. This is not so. Bugs will shelter in its metallic crevices almost as comfortably as in the wooden chinks of its predecessor. Its presence does not necessarily indicate neglect or want of cleanliness. It is apt to get into trunks and luggage, and in this way may be conveyed even into the best-kept homes. It is also very migratory and will pass readily

from one house to another, and when an infested dwelling is vacated these insects usually leave it for better company and better quarters. Their food-supply being withdrawn, they make their way along gutters, water-pipes, &c., into adjoining and inhabited houses. *Cimex* is particularly common in ships—especially emigrant ships—and, although unknown to the aboriginal Indians of North America, it probably entered that continent with the 'best families' in the *Mayflower*.

Perhaps the most disagreeable feature of the bed-bug is that it produces an oily fluid which has a quite intolerable odour; the glands secreting this fluid are situated in various parts of the body. The presence of such glands in free-living Hemipterous insects is undoubtedly a protection—birds will not touch them. One, however, fails to see the use of this property in the bed-bug. At any rate, it does not deter cockroaches and ants, as well as other insects, from devouring the *Cimex*. There is a small black ant in Portugal which is said to clear a house of these pests in a few days, but one cannot always command the services of a small black Portuguese ant.

Another remarkable feature is that the insect has no wings, although in all probability its ancestors possessed these useful appendages. As the American poet writes :—

The Lightning-bug has wings of gold,
The June-bug wings of flame,
The Bed-bug has no wings at all,
But it *gets* there all the same!

The power of 'getting there' is truly remarkable. Man, their chief victim, has always warred against bugs, yet, like the poor, bugs 'are always with us.' I heard it stated, when I was living in southern Italy, that if you submerged the legs of your bed in metal saucers full of water and placed the bed in the centre of the room, the bugs will crawl up the wall, walk along the ceiling and drop on to the bed and on to you. Anyhow, whether this be so or not, there is no doubt that these insects have a certain success in the struggle for life, and only the most systematic and rigorous measures are capable of ridding a dwelling of their presence.

FIG. 4.—Egg of *Cimex lectularius*. Enlarged. (After Marlatt.)

The eggs of the bed-bug are pearly white, oval objects, perhaps 1 mm. in length. At one end there is a small cap surrounded by a projecting rim, and it is by pushing off this cap, and through the orifice thus opened, that the young bug makes its way into the outer world after an incubation period of a week or ten days. There is no metamorphosis—no caterpillar and

no chrysalis stages. The young hatch out, in structure miniatures of their parents, but in colour they are yellowish-white and nearly transparent. The young feed readily, and feeding takes place between each moult, and the moults are five in number, before the adult imago emerges. This it does about the eleventh or twelfth week after hatching.

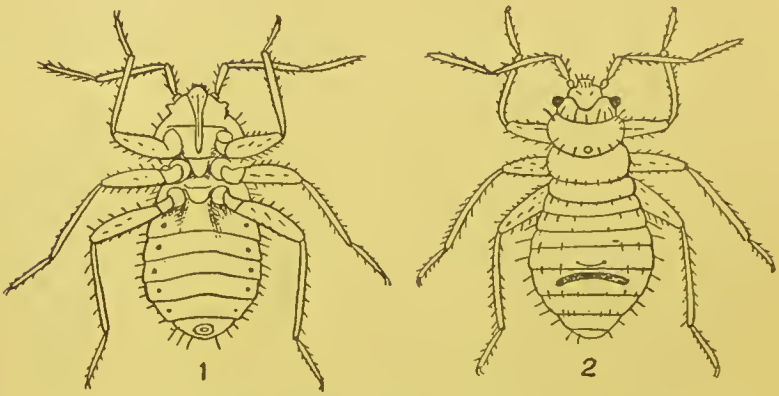


Fig. 5.—Newly hatched young of *Cimex lectularius*. 1, Ventral view; 2, dorsal view. Enlarged. (After Marlatt.)

These time-limits depend, however, upon the temperature after hatching, and the rate of growth depends not only upon the temperature but also upon the amount of food.

When bred artificially and under good conditions, the rate of progress can be 'speeded up' so that the eggs hatch out in eight days, and every following moult takes place at intervals of eight days, so that the period from

egg to adult can be run through in as short a time as seven weeks.

Unless fed after each moult, the following moult is indefinitely postponed. Hence it follows that in the preliminary stages bugs must bite their hosts five times before the adult form emerges, and the adult must, further, have a meal before she lays her eggs. The eggs are deposited in batches of from five to fifty in cracks and crevices, into which the insects have retired for concealment.

Bugs can, however, live a very long time without a meal. Cases are recorded in which they have been kept alive for more than a year incarcerated in a pill-box. When the pill-box was ultimately opened, the bugs appeared to be as thin as oiled paper and almost so transparent that you could read *The Times*[1] through them; but even under these conditions they had managed to produce offspring. De Geer kept several alive in a sealed bottle for more than a year. This power of existing without food may explain the fact that vacated houses occasionally swarm with bugs even when there have been no human beings in the neighbourhood for many months.

The effect of their bite varies in different people. As a rule, the actual bite lasts for

[1] Only the larger print, such as the leading articles and letters from Admirals.

two or three minutes before the insect is gorged, and at first it is painless. But very soon the bitten area begins to swell and to become red, and at times a regular eruption ensues. The irritation may be allayed by washing with menthol or ammonia. Some people seem immune to the irritation; and I know friends who, in the West Indian Islands, have slept through the attacks of thousands of bugs, and only awoke to their presence when in the morning they found their night-clothing and their sheets red with blood, expressed from the bodies of their tormentors as the victims turned from side to side.

As a rule, the uncovered parts of the body —the face, the neck, and the hands—are said to be more bitten than the parts which are covered by the bedclothes. This was not, however, my experience in southern Italy.

The bug has been accused of conveying many diseases—typhus, tuberculosis, plague, and a form of recurrent fever produced by a spirochaete (*Spirochaeta recurrentis*); but some doubt has been thrown upon the justice of the accusation, and Professor C. J. Martin writes as follows :—

> There is really no evidence to incriminate the bed-bug in the case of either typhus or relapsing fever. It is possible to transmit plague experimentally by means of bugs, but there is no epidemiological reason

for supposing this takes place to any extent in nature.

There are two differences in the habits of bugs and those of fleas and lice which may possess epidemiological significance. The first concerns the customary intervals between their meals. Bugs show no disposition to feed for a day or two after a full meal, whereas fleas and lice will suck blood several times during the twenty-four hours. The second is in respect to the time the insects retain a meal and the extent to which it is digested before being excreted. Fleas and lice, if constantly fed, freely empty their alimentary canals, and the nature of their faeces indicates that the blood has undergone but little digestion.

Both these insects evacuate such undigested or half-digested blood *per rectum* during the act of feeding, and the remnants of the previous meal are thus deposited in the immediate vicinity of a fresh puncture. It is not unlikely that, should the alimentary canal of the insect be infected with plague bacilli, spirochaete, or the organism responsible for typhus fever, these may be inoculated by rubbing or scratching. Bugs have not this habit; and in all the cases I have examined their dejections were fully digested, almost free from protein, and consisted mostly of alkaline haematin.

On the other hand, Tictin and Karlinski have at different times found spirochaetes of relapsing fever in bed-bugs fed on patients infected with the disease, and in bugs taken in the houses of such patients. Monkeys were

infected from crushed bugs containing the spirochaetes. In India the bed-bug is under suspicion of spreading kala-azar or 'black fever.' Other insects probably convey similar diseases in various parts of the tropics and sub-tropics, as is indicated by the recent experiments of Prof. Laveran and Dr. Franchini in Paris, and Drs. Fantham and Porter in Cambridge. Whether bugs be guilty of these crimes or not, they are the cause of an intense inconvenience and disgust, and should, if possible, be dealt with drastically. At the present time[1] there are rumours that some of our largest camps are infested with these insects, and there seems no doubt that some of the prisoners and refugees to this country have brought their fauna with them, and this fauna is very capable of spreading in concentration camps. The erection of wooden huts—no doubt a pressing necessity—will afford convenient quarters for these pests.

Among the measures which have been most successful in the past has been fumigating houses with hydrocyanic-acid gas; but this is a process involving considerable danger, and should only be carried out by competent people under the most rigorous conditions. In all fumigating experiments every crack and cranny of a house should be shut, windows

[1] September 1914.

closed, keyholes blocked, and so on. A second method of fumigation is that of burning sulphur. Four ounces of brimstone are set alight in a saucer, this in its turn is placed in a larger vessel, which protects the floor of the room from a possible overflow of the burning material. After all apertures have been successfully plugged, four or five hours of the sulphurous fumes are said to be sufficient to kill the bugs, but to ensure complete success a longer time is needed. This is not only a much less expensive but a much less dangerous operation than using hydrocyanic-acid gas. Two pounds of sulphur will suffice for each thousand cubic feet of space, but it is well to leave the building closed for some twenty-four hours after the fumigation. Another more localised method of destroying these pests is the liberal application of benzine, kerosene, or any other petroleum oil. These must be introduced into all crevices or cracks by small brushes or feathers, or injected with syringes. In the same way oil of turpentine or corrosive-sublimate has proved effective. Boiling water is also very fatal when it can be used ; and recently in the poorer quarters of London the ' flares ' which painters use in burning off paint have proved of great use in ridding matchboarding, or wainscoting, from the harbouring bugs. Passed quickly

along, the flame of the 'flare' does not burn the wood, but it produces a temperature which is fatal to the bug and to its young and to its eggs. And thus :—

'This painted child of dirt, that stinks and stings'[1] is destroyed.

[1] Pope's *Epistle to Dr. Arbuthnot.*

CHAPTER III

THE FLEA (*Pulex irritans*)

Marke but this flea, and marke in this,
How little that which thou denyst me is;
It sucked me first, and now sucks thee,
And in this flea our two bloods mingled bee.
(Dr. Donne.)

The fact, now fully established, that the bubonic plague is conveyed to man from infected rats, or from infected men to healthy men, by fleas has taken that wingless insect out of the category of those animals which it is indelicate to discuss.

No doubt, as Mr. Dombey says, '*Nature is on the whole a very respectable institution*'; but there are times when she presents herself in a form not to be talked about, and until a few years ago the flea was such a form. Hence, few but specialists have any clear idea either of the structure or of the life-history or of the habits—save one—of the flea.

Fleas are temporarily parasitic on many mammals and birds, but some mammals and

some birds are much freer from fleas than others. As the flea is only on its host for part of the time, it has to put in the rest of its existence in some other place, and this, in the case of the human flea, is usually the floor, and in the case of bird-fleas the

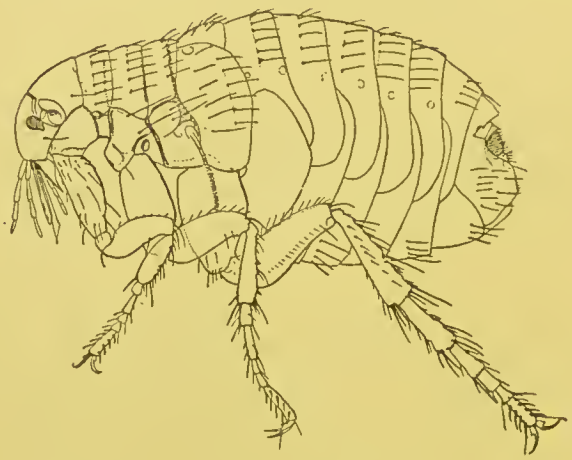


FIG. 6.—*Pulex irritans*, female. The legs of the left side only are shown. Enlarged. (After a drawing by A. Dampf.)

nest; from these habitats they can easily regain their hosts when the latter retire to rest. But large numbers of Ungulates—deer, cattle (except when domesticated), antelopes, goats, wild boars—usually sleep in different places each recurrent night, and to this is probably due the fact that, with the exception of two rare species—one taken in Northern China and the other in Transcaucasia—the Ungulates have furnished de-

scriptive science with no fleas at all. Both of these Ungulate fleas are allied to the burrowing-fleas or 'chigoes.'

I know none of my readers will believe me when I say that the same is true of monkeys; but I do this on the undoubted authority of Mr. Harold Russell, who has recently published a charming little monograph on these lively little creatures. Monkeys in nature are cleanly in their habits; and although in confinement occasionally a human flea attacks them, and although occasionally a chigo bores into the toes of a gorilla or chimpanzee, 'speaking generally, it may be said that no fleas have been found truly parasitic on monkeys.' Whatever the monkeys are looking for, it is not fleas. What they seek and find is in effect little scabs of scurf which are made palatable to their taste by a certain sour sweat.

As a rule, each host has its own species of flea; but though for the most part *Pulex irritans* is confined to man it is occasionally found on cats and dogs, whilst conversely the cat- and dog-fleas (*Ctenocephalus felis* and *Ct. canis*) from time to time attack man.

The bite of the flea is accompanied by the injection of the secretions of the so-called salivary glands of the insect, and this secretion retards the coagulation of the victim's blood,

stimulates the blood-flow, and sets up the irritation we have all felt.

It is only a few years ago that the spread of bubonic-plague was associated first with rats, and then with rat-fleas ; and at once it became of enormous importance to know which of the numerous species of rat-flea would attack human beings. The Hon. Charles Rothschild, who has accumulated a most splendid collection of preserved fleas in the museum at Tring, had some years ago differentiated from an undifferentiated assemblage of fleas a species first collected in Egypt, but now known to be the commonest rat-flea in all tropical and subtropical countries. This species *Xenopsylla cheopis*—and to a lesser extent *Ceratophyllus fasciatus*—unfortunately infests and bites man. If they should have fed upon a plague-infected rat and subsequently bite man, their bites communicate bubonic plague to human beings. Plague—the Old English ' Black Death '—is a real peril in our armies now operating in Asia and in certain parts of Africa.

Just as some fleas attack one species of mammal or bird and avoid closely allied species, so the human flea has its favourites and its aversions. There is a Turkish proverb which says ' an Englishman will burn a bed to catch a flea,' and those who suffer severely from flea-

bites would certainly do so. The courage of the Turk in facing the flea, and even worse dangers, may be, as the schoolboy wrote, 'explained by the fact that a man with more than one wife is more willing to face death than if he had only one.' But there are persons even a flea will not bite. Mr. Russell has reminded us in his Preface of the distinguished French lady who remarked, 'Quant à moi ce n'est pas la morsure, c'est la promenade!'

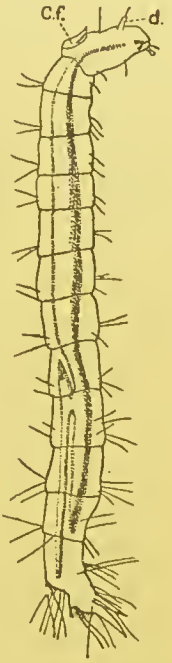


FIG. 7. — Larva of *Pulex irritans*. *C.f.* frontal horn; *d*, antenna. Enlarged. (After Brumpt.)

There are one or two structural features in a flea which are peculiar: the most remarkable being that, unlike most other insects, it is much taller than it is broad. As a rule, insects—such as a cockroach, the bed-bug, or a stag-beetle—are like skates, broader than they are tall, but the flea has a laterally compressed shape, like a mackerel or a herring. Then, again, the three segments or rings which come after the head are not fused into a solid cuirass or thorax as they are in the fly or the bee, but they are movable one on the other. Finally, it is usual in insects for the first joint of the leg to be pressed up against and fused with those

segments of the body that bear them; but in the flea not only is this joint quite free, but the body-segment gives off a projection which stretches out to bear the leg. Thus the legs seem, unless carefully studied, to have an extra joint and to be—as indeed it is—of unusual length. They certainly possess unusual powers of jumping—as Gascoigne, a sixteenth-century poet (1540–78) writes, 'The hungry fleas which frisk so fresh.'

The male, as is so often the case amongst the Invertebrata, is much smaller than the female. The latter lays at a time from one to five minute, sticky, white eggs, one-fortieth of an inch long by one-sixtieth broad. They are not laid on the host, but in crevices between boards, on the floor, between cracks in the wainscoting, or at the bottom of a dog-kennel or in birds' nests. Mr. Butler recalls the case of a gentleman who collected on four successive mornings sixty-two, seventy-eight, sixty-seven, and seventy-seven cat-fleas' eggs from the cloth his cat had slept upon. Altogether 284 eggs in four nights! The date of hatching varies very much with the temperature. *Pulex irritans* takes half as long again—six weeks instead of four—to become an adult imago in winter than it does in summer. But in India the dog-flea will complete its cycle in a fortnight.

When it does emerge from the egg the larva is seen to be a whitish segmented little grub without any limbs, but with plenty of bristles which help it to move about; this it does very actively. There are two small antennae and a pair of powerful jaws, for the larva does not take liquid food, but eats any scraps of solid organic matter which it comes across; dead flies and gnats are readily devoured. The larva casts its skin several times, though exactly how often it moults seems still uncertain.

Fig. 8.—Pupa of flea. (After Westwood.)

After about twelve days of larval existence it spins itself a little cocoon in some sheltered crevice, and turns into a whitish inert chrysalis or pupa. During its pupal existence it takes, of course, no food, but it grows gradually darker, and after undergoing a tremendous internal change, breaking down its old tissues and building up new ones, the chrysalis-case cracks and the adult flea jumps out into the world.

There is an insect people avoid,
Whence is derived the verb to flee.

There are many superstitions about fleas. March 1st is in some way connected with them, and in the south of England the house-doors

are in some villages closed on that day under the belief that this will render the building immune for the following twelve months.

The most successful insecticide is said to be prepared from *Pyrethrum*, which is grown in the Near East in large quantities for this purpose. But the Austrians, the Serbians, and the Montenegrins are fighting over the chief world-supply of this plant—possibly without knowing what they are doing—and '*Insekten-pulver*' is bound to go up in price. Wormwood (*Artemisia*) is also recommended.

> While wormwood hath seed, get a handfull or twaine,
> To save against March, to make flea to refraine;
> When chambere is swept and wormwood is strowne,
> No flea for his life dare abide to be known.
>
> (Tusser.)

To catch so nimble an insect as a flea requires keen vision and an active finger. But should one be tormented by a *Pulex* it is not a bad plan to turn one's garments inside-out over a bath, or, failing a bath, over a washing-basin full of water, the betting is on the flea leaping into a watery grave and the 'rest is silence.'

The author of 'A Thousand Notable Things' suggests the following plan, but, so far, I have not met anyone who has tried it: 'If you mark where your right foot doth stand at the first time that you do hear the cuckow, and then grave or take up the earth under

he same; wheresoever the same is sprinkled about, there will no fleas breed. I know it hath proved true.'

Plastering a floor with cow-dung is a common practice in South Africa, and seems to be an efficacious means of keeping down fleas. Dr. R. J. Drummond tells me that all natives of India and Ceylon spread an emulsion of cow-dung in hot-water over the floors and the walls of their dwellings to keep out fleas. This has been done from immemorial times, and is effective. The efficacy of the emulsion in keeping fleas away has been doubted, and so I am glad to quote a few lines from a kind letter sent me by Dr. P. A. Nightingale of Victoria, Southern Rhodesia, which put the matter in a happy light :—

I think the correct facts are these : the floors of certain houses, huts, &c., throughout the South African veld are made of ant-heap earth, moistened and beaten hard and flat with sticks. This floor is then smeared at regular intervals—say, every ten days—with fresh cow-dung, when the room becomes fresh and sweet (!) and free from insects.

However, before the smearing can be done it is necessary to turn all the furniture out of the room and to sweep it thoroughly; after the smearing, the doors and windows are left open for drying purposes.

Hence, I think that the absence of fleas in such quarters is really due to general cleanliness, sunlight,

and fresh air, and not to any special virtue in the cow-dung.

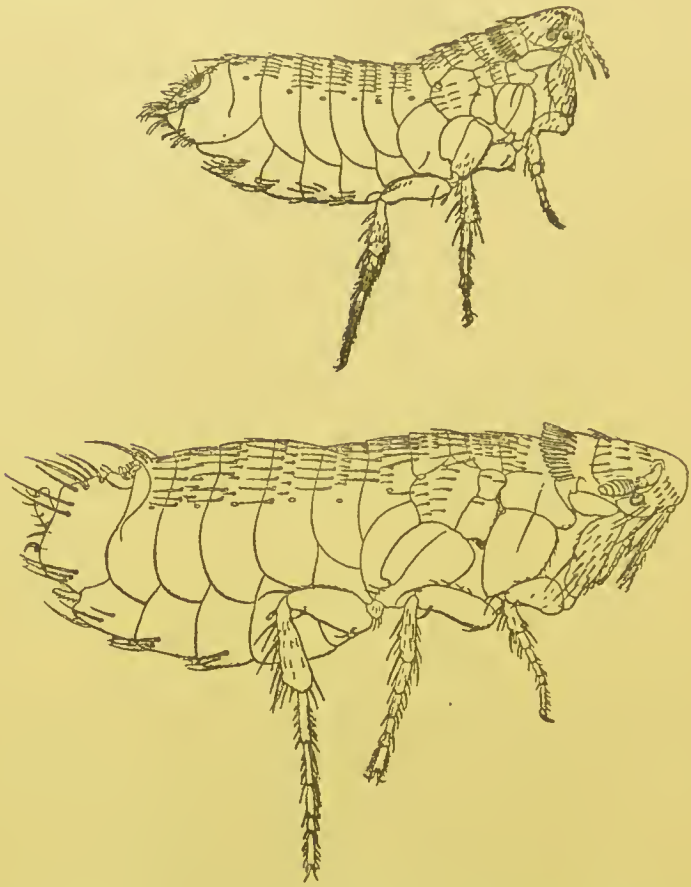


Fig. 9.—*Ceratophyllus gallinulae.* Male (above) and female (below). Drawn to scale and both highly magnified. These specimens, taken from a grouse, are of the same genus as one of the plague-conveying fleas.

I am, however, sure that the smearing of the floor at frequent intervals *does* keep many pests down by filling up, and temporarily sealing, the numerous cracks in the floor where fleas, &c., reside and breed in vast numbers.

Huts—especially unused ones—not smeared for many weeks contain (approximately) several thousands of fleas, white ants, centipedes, and scorpions to the square inch, when the only treatment is to cleanse the walls and floor with cyanide solution, or burn the whole place down.

From long experience, I am very nearly insect proof; but cannot stand the myriads of fleas I occasionally have to sleep with in a hut of the above description—especially just before the rains set in, when additional veld pests come into the huts for shelter.

We must, in the long run, treat fleas seriously. Although the *Pulex irritans* is a very common insect, the greatest living authority on fleas tells me it has never been accurately drawn. We have Blake's 'ghost of a flea'; but what did Blake know of entomology? In distinguishing one flea from another—fleas which may attack man and fleas which have hitherto declined to do so—every hair, every bristle, counts. Hence, I illustrate this article with accurate outlines of certain fleas found on the grouse, and for whose accuracy I can vouch (Fig. 9).

As I have said above, a certain rat-flea (*Xenopsylla cheopis*) and another (*Ceratophyllus fasciatus*) undoubtedly convey the bacillus of plague from rats and other Murinae to man and vice versa. The *Bacillus pestis* is unlikely to establish itself in the present war in Europe,

but *Quién sabe?* The Black Death of 1349–51 was conveyed by fleas, and so was Pepys's Plague of 1665. Plague—flea-borne, we must remember—is still endemic in places as near Europe as Tripoli, and in numerous centres in Asia. Not a disease altogether to be neglected, since the spread of war to the Near East, but still not very threatening in Europe in the twentieth century.

CHAPTER IV

THE FLOUR-MOTH (*Ephestia kühniella*) IN SOLDIERS' BISCUITS

Where moth . . . doth corrupt. (MATT. vi. 19.)

IT is not only those insects that destroy the continuity of our soldiers' integument which play a part in war. It has been well said that an army marches on its stomach, and the admirable commissariat arrangements which have been so distinctive a feature of the British Expeditionary Force during the present war are the result of much patient care and attention during times of peace. I am in no position to discriminate, but I do believe that the admirable service of the A.S.C. and the R.A.M.C. is at least equal to the splendid record of those in the fighting-line.

Every one knows that recruits are frequently rejected for some defect in their teeth. A soldier, indeed, requires strong teeth, for his farinaceous food in the field is largely supplied to him in the form of biscuits—not that 'moist

and jovial sort of viand,' as Charles Dickens described the Captain biscuit, but 'hard-tack' which challenges the stoutest molars.

During the summer of 1913 the authorities of the British Museum at South Kensington arranged a very interesting but somewhat gruesome exhibit in their Central Hall. The exhibit consisted mainly of Army biscuits

FIG. 10.—*Ephestia kühniella.* Moth-infested biscuit.

eaten through and through by the larva of a small moth and covered by horrible webs or unwholesome-looking skeins of silky threads.

Together with these derelict biscuits were certain long metallic coils and other apparatus used in investigating certain phases of the life-history of the moth and the manufacture of the biscuit. The exhibit illustrates an article which had recently appeared on the

Baking of Army Biscuits, by Mr. Durrant and Lieut.-Colonel Beveridge, on the 'biscuit-moth' (*Ephestia kühniella*), a member of the family Pyralidae. The article recorded their efforts to arrive at a means of checking this very serious pest to service stores.[1]

The biscuit-moth (*E. kühniella*) was described two years before its larva had been noted damaging flour at Halle. There has always been a certain amount of international courtesy in attributing the *provenance* of insect pests to other countries; and when *E. kühniella* began, about ten years later, to attract attention in England it was believed to have been introduced from the United States, via the Mediterranean ports, in American meal. The American origin was, however, denied by Professor Riley, who, in a letter to Miss Ormerod, states, 'I think I can safely say that this species does not occur in the United States.' At the moment of writing these words Professor Riley was in the act of packing-up to leave Washington for Paris. Possibly he was excited, certainly he was inaccurate, for the species was then known to be prevalent in Alabama, North Carolina, and other States. In fact, to-day it is recorded throughout Central America and the

[1] *Journ. Roy. Army Med. Corps*, vol. xx. No. 6, 1913. The figures in this chapter are taken from this article.

Southern States, and in most of the temperate regions of the New World.

The moth inself is a rather insignificant, small insect, of a quakerisk, slatey-grey colour. Its eggs, rather irregular ovoids, are laid upon the biscuit into which the issuing larvae bore. These latter are soft and like most creatures which live in the dark, whitish, though with a tinge of pink; the head, however, is brown and hardened. The larva is constantly spinning silken webs or tissues, which in the most untidy way envelop the biscuit. It finally entombs itself in a whitish silken cocoon, and herein it ultimately turns into a chrysalis or pupa.

FIG. 11.—*Ephestia kühniella.* × 2.

Another Pyralid moth—*Corcyra cephalonica*—makes similar unpleasant webs all over biscuits, rice, or almost any farinaceous food; but, since its larvae are unable to live unless there be a certain degree of moisture in its food, it is less injurious to baked food than the *Ephestia*, for whose larvae nothing can be too dry. *Corcyra* seems originally to be a pest of rice, and to have been introduced into Europe with Rangoon rice; but it readily alters its diet in new

surroundings, and will live on almost any starchy stuff, if not too desiccated.

The problem that Lieut.-Colonel Beveridge and Mr. Durrant, of the British Museum, set out to solve was at what stage in the manufacture of the Army biscuits does our soldiers' food become infested, and whether

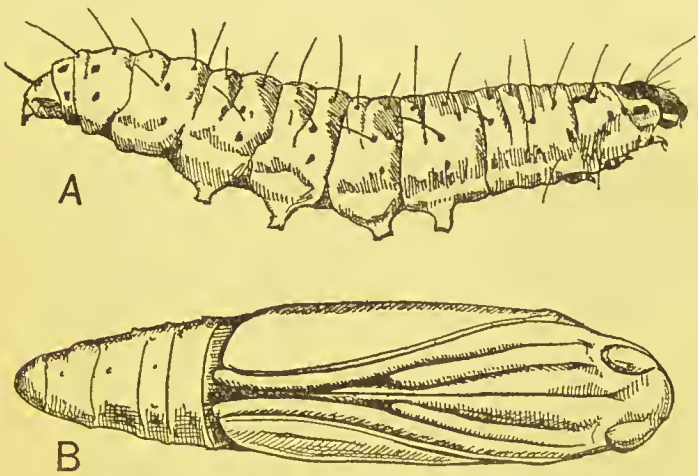


FIG. 12.—*Ephestia kühniella.* A, Larva; B, pupa. Greatly magnified.

any steps could be taken to avoid or minimise such infestation.

First, as to infestation. The biscuit must become infested either (1) at home before packing, (2) during transit, or (3) in the country where they are stored. The biscuits are packed in tins, hermetically sealed, and enclosed in wooden cases to prevent injury;

it was therefore obvious that if insects could be found within intact tins it would be demonstrated at once that infestment must have taken place in the factories, and not subsequently. With a view to determine

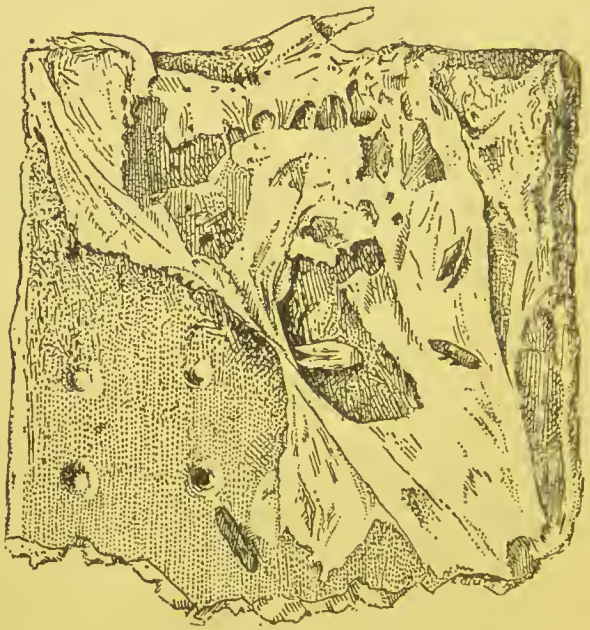


Fig. 13.—*Corcyra cephalonica.* Moth-infested biscuit.

the origin of infestation sample tins were withdrawn from stocks at various stations abroad, and inspected by experts at Woolwich; and tins which, after careful examination, had been pronounced intact, were found to contain *Ephestia kühniella* and *Corcyra cephalonica* in various stages of development, thus

proving conclusively that infestation had taken place in the factories before the tins were soldered, and indicating that preventive or remedial measures must be undertaken within the biscuit-making factories themselves.

It is obvious either that the heat to which the biscuit is subjected in the process of baking is insufficient to destroy any of the insect eggs present in the moist dough or that the moths and beetles deposit their eggs in or on the biscuits after baking, and during the process of cooling and of packing into the tins. Cooling before packing is necessary in order to allow the moisture in the centre of the biscuit to become evenly distributed throughout the 'tissue' of the biscuit. And it is during the time occupied in cooling and packing that the biscuit is exposed to the greatest risk of infestation; any risk occasioned by subsequent injury must be exceptional, and is probably negligible.

By a series of most ingenious experiments, the two investigators were able to determine the temperature in the centre of the biscuits during the various stages of its baking and cooling. Army biscuits are made from dough which contains about 25 per cent. of water. When stamped out they are placed in rows on the revolving floor of an oven, and are submitted to a high tempera-

ture for twenty minutes whilst they travel over a space of 40 feet. The dough at first contains, as we have said above, 25 per cent. of water, but during baking this is reduced to about 10 per cent., and the moisture now collects in the centre of the mass of the biscuit in consequence of the external hardening or 'caramelisation,' as it is called. The holes which are pricked in so many biscuits of course help to equalise the spread of the moisture throughout the biscuit.

Too little attention has been paid to the internal temperature of edibles which are being cooked. Very few people, for instance, have any conception of what is going on in the centre of a joint of meat whilst it is being roasted or boiled. After two hours' boiling the temperature in the centre of a large ham has only risen to 35° C.; after six hours' boiling to 65° C., and it is only after ten hours' continuous boiling that 85° C. is reached. I have, I am sorry to say, no conception as to how long a ham ought to be boiled, but it is obvious that to be really effective against such parasites as *Trichinella*—the *causa causans* of trichinosis—the cooking of pork and ham should be more prolonged and thorough than seems to be customary. But that is another story.

However, to return to our biscuits. The

Colonel and Mr. Durrant devised an ingenious instrument which determined the rising temperature at the centre of our Army biscuits whilst baking. When the tip of their recording apparatus lay within the moist area of the biscuit, the temperature registered was only a little over 100° C.; but when the tip of the instrument rested on the hard 'caramelised' portion much higher temperatures were observed —even as high as 125° C. Colonel Beveridge and Mr. Durrant were thus able to establish the fact that the temperatures of the biscuit were, during baking, such as to rule out the idea that the eggs of the biscuit-moth—which do not survive a temperature of 69° C. for twelve minutes—were deposited in the biscuit before cooking.

After the baking is completed the biscuits are cooled, and it is at this period that they are most exposed to risk of infestation by *Ephestia kühniella*. This insect is a well-known nuisance in Flour-mills. So persistent and numerous are these moths at times that they clog the rollers with their cocoons, and sometimes completely stop them. The webbing of the elevators in the mills gets covered with them and with their silky skeins, and then the elevators stop working. They mat together the flour and meal with their silken excreta, and so uniform is the tempera-

ture of the Mill, and so favourable to the life of the insect, that they complete their life-cycle in this country in two months, and in the warmer parts of America even more rapidly. In well-heated mills the proceeding is continuous, so that six generations at least may be produced each year.

The most efficient method of getting rid of this pest of the Army biscuit is a complete and thorough fumigation of the infested premises with carbon bisulphide. But, as this substance is not only poisonous but inflammable, it is well to get a chemist to undertake the proceeding, and also to notify the Insurance Company. Fumigation by sulphur ruins the flour. Another remedial measure is that of turning the steam from the boilers on to all the infected machinery and walls.

That this destruction of the Army biscuit is a matter of considerable importance is shown by the fact that biscuit-rations exported to the colonies in hermetically sealed tins have become quite unfit for consumption, and this destruction has been noted in places as far distant from each other as Gibraltar, the Sudan, Mauritius, Ceylon, South Africa, and Malta. That it is also an old trouble is shown by the following quotation from the diary which Sergeant Daniel Nicol, of the 92nd (the Gordon Highlanders), kept during the expedition to Egypt in 1801 :—

Some vessels were dispatched to Macri Bay for bullocks, and others to Smyrna and Aleppo for bread which was furnished us by the Turks—a kind of hard dry husk. We were glad to get this, as we were then put on full rations, and our biscuits were bad and full of worms; many of our men could only eat them in the dark.[1]

With regard to the actual baking of the biscuit, Colonel Beveridge and Mr. Durrant suggest that the temperature conditions during the process of cooling should be made as unfavourable as possible for the moths by introducing screened cool air, which can be forced in at one end of the cooling-chamber and sucked out at the other. Could such a scheme be adopted it would be difficult, if not impossible, for the moths to lay their eggs, and the biscuit would thus be more rapidly cooled. In any case it should not be difficult to ensure that the cooling takes place in some chambers which are practically free from these destructive moths.

[1] *With Napoleon at Waterloo.* By Edward Bruce Low; edited by Mackenzie MacBride; p. 21. London: Francis Griffiths, 32 Maiden Lane, Strand, W.C. 1911.

CHAPTER V

FLIES

Part I

THE HOUSE-FLY (*Musca domestica*)

Musca est meus pater, nil potest clam illum haberi;
Nec sacrum nec tam profanum quidquam est, quin Ibi ilico adsit.

(Plautus, *Mercator.*)

'The common house-fly [says Ruskin] is the most perfectly free and republican of creatures. There is no courtesy in him; he does not care whether it is a king or clown whom he teases, and in every step of his swift mechanical march and in every pause of his resolute observation there is one and the same perfect expression of perfect egotism, perfect independence and self-confidence and conviction of the world having been made for flies. Your fly free in the air, free in the chamber, a black incarnation of caprice, wandering, investigating, fleeting, flitting, feasting at his will with rich variety of feast from the heaped sweets in the grocer's window to those of the butcher's back yard, and from the galled place on your horse's neck to the brown spot on the

road from which, as the hoof disturbs him, he rises with angry republican buzz; what freedom is like his?'

The house-fly is all that Ruskin describes it to be, but it is more. It is the most cosmopolitan of insects. Wherever man is there is the fly. It comes—

> From Greenland's icy mountains,
> From India's coral strand.

But it is naturally more frequent in warm climates than in cold, as the rate of its development depends very largely upon an average high temperature.

Unlike the lice and the bed-bug, the fly like the flea, passes through a complete metamorphosis—egg, larva, pupa, and imago. It will breed in almost any rotten matter, whether vegetable or animal, and it breeds most successfully, as Gordon Hewitt has pointed out, when certain processes of organic fermentation are taking place in its breeding-place. Probably the fermentation has a favourable effect upon the food of the larvae. Undoubtedly the place most readily selected by the female for laying her eggs is stable-manure. A few years ago there was a remarkable reduction in the number of house-flies in London, and Lord Montagu of Beaulieu attributed this reduction to the refreshing and

insecticidal petrol vapour with which the streets of that town were then bathed. I do not know what experiments Lord Montagu had made on the subject of the insecticidal value of petrol vapour, but the ordinary man

Fig. 14.—Mass of eggs of *M. domestica*. (From Gordon Hewitt.)

in the street attributed—and I think more correctly—the diminution of the plague of flies to the absence of the nidus in which the female fly lays her eggs. Stable-yards had been turned into garages. But flies will, indeed, breed in almost any kind of dejecta—including the human—and in rotten straw, rotten wool,

rotten cotton garments, decaying vegetables and fruits, bad meat, rotten grain, and even in spittoons, but they prefer horse-manure.

In our country house-flies usually begin to breed in June and July, continuing well on into October if the weather be but warm. Their greatest activity is, however, in the hotter month of August and the beginning of September. But in warm stables, restaurants, and kitchens flies are able to reproduce the whole year round. A single fly will deposit at one time 100 to 150 eggs, and in the course of her summer life may produce five, or even six, batches of ova of this size. The eggs are pearly white, elongated structures, with two converging lines, along which the egg-case will ultimately split to give exit to the larva. The eggs are laid, by means of a long ovipositor, a little way beneath the surface of the dung-heap in a position where they will not readily be dried up. In favourable conditions the eggs hatch in from eight to twenty-four hours.

Fig. 15.—Eggs of *M. domestica*, × 40. (From Gordon Hewitt).

The larvae are legless, tapering towards the head, which bears a pair of breathing-holes, or spiracles; their bodies are much stouter towards the hinder end. On the whole they are white,

unpleasant-looking maggots, called by fresh-water fishermen 'gentles.' By contracting and expanding its body it pushes its way through the moist, semi-liquid surroundings. The skin is usually moulted some twenty-four hours after birth, but all these time-limits depend much upon the temperature and favourable conditions. With normally high temperatures—say, with 30° C. to 35° C.—the larva will become fully grown in five or six days. The third and final larval stage, after the second moult or ecdysis, lasts three days, and when fully grown the maggots are now about half an inch in length. Externally, twelve segments are visible, but the internal anatomy shows that thirteen are really present, though one is almost 'masked.'

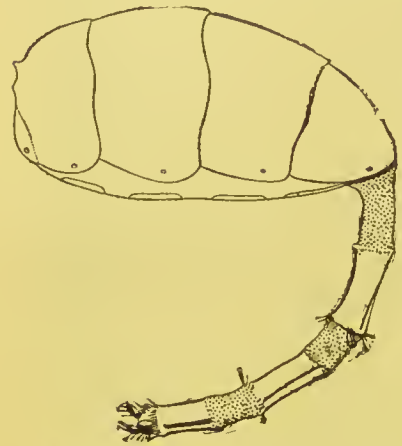


FIG. 16.—Abdomen of female house-fly, showing the extended ovipositor. (From Gordon Hewitt.)

It is only during these larval stages that the insect grows, and it is never more bulky than in the third larval stage. Now it leaves the moist situation, in which it has flourished, and, crawling through the manure, seeks some dry or sheltered corner near the surface of

the manure heap. For a time it rests, and then after an hour or two's quiescence it retracts its anterior end and assumes a barrel-shaped outline, its creamy white colour slowly changing to a mahogany brown. The larval skin forms the pupa-case, and within this pupa-case the body of the larva undergoes a wonderful change, far greater than even human beings undergo at the time of puberty. Many

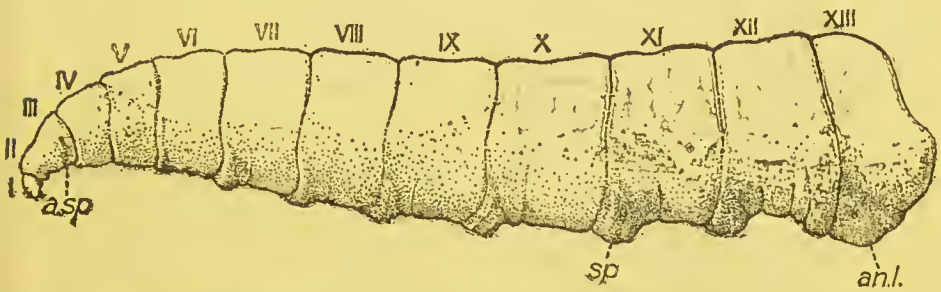


Fig. 17.—Mature larva of *M. domestica*. *a.sp*, Anterior spiracular process; *an.l*, anal lobe; *sp*, spiniferous pad. I–XIII, Body segments. (From Gordon Hewitt.)

of its organs are disintegrated and re-formed, and in the course of three or four days the white, legless, repellent maggot, who 'loves darkness rather than light,' is changed into a lively, flying insect, seeking 'a place in the sun' and the companionship of man. As the Frenchman said of the pig which goes into one end of the machine in the Chicago meat-factory as live pig and comes out at the other end in the form of sausages, 'Il est diablement changé en route.'

In a very short time after leaving the pupa-case the adult fly has stretched her wings, the chitin of her body has hardened, and she flies away 'on her several occasions.'

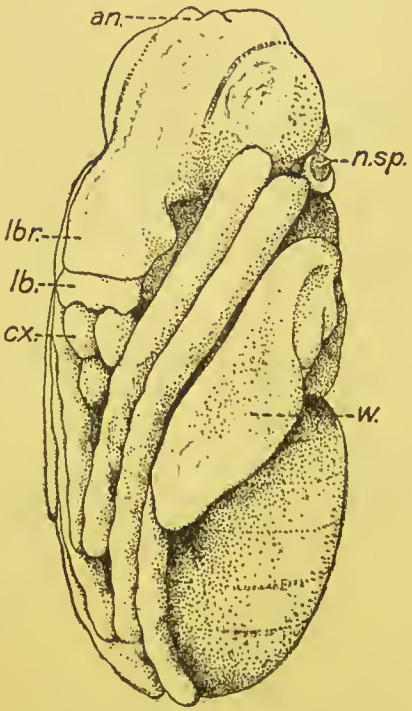


FIG. 18.—'Nymph' of *M. domestica* dissected out of pupal-case about thirty hours after pupation. *an*, Swellings of nymphal sheath marking bases of antennae; *cx*, coxa of leg; *lb*, labial portion of proboscis sheath; *lbr*, labral portion of same; *n.sp*, spiracular process of nymph; *w*, wing in nymphal alar sheath. (From Gordon Hewitt.)

Flies become sexually mature in a week or ten days after emerging from the chrysalis-case, and are capable of depositing their eggs four days after mating, so that if the conditions be indeed favourable the whole development from the egg to the perfect fly may be accomplished in nine or ten days, and the second generations are able to lay their eggs ten days later. The appalling fecundity of such an insect explains the fact that in the hotter parts of the world nearly every edible thing seems to be covered with them.

The proboscis of a fly can only suck up

liquid food; and when we see it feeding on solid substances, such as sugar, it has really dissolved the sugar by depositing some saliva on it, and is sucking up the sugary solution so produced. It not infrequently regurgitates its food in a spherical drop, which it generally reabsorbs.

As we have seen, flies are very susceptible to temperature, and with the approach of cold weather they seem to die. We used to think that some, in a state of suspended animation, 'carried on' through the winter months. This is, however, 'non-proven.' Many of them undoubtedly die in the autumn, as bees die, of old age. They are literally worn out.

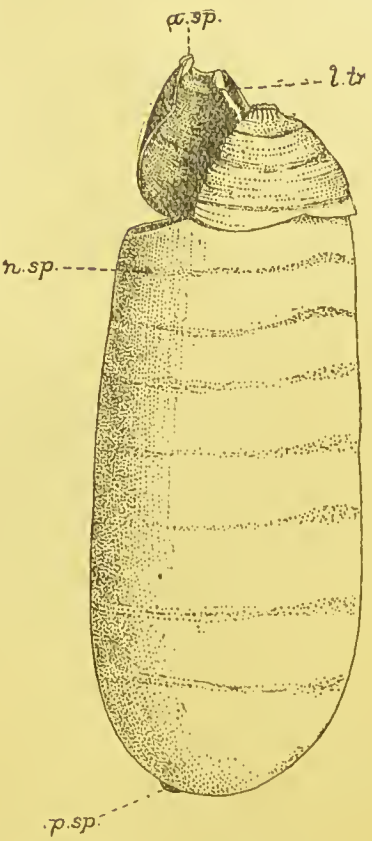


FIG. 19.—Pupal-case or puparium of *M. domestica* from which the imago has emerged, thus lifting off the anterior end or 'cap' of the pupa; ventro-lateral aspect. *a.sp*, Remains of the anterior spiracular process of larva; *l.tr*, remains of the larval lateral tracheal trunk; *n.sp*, temporary spiracular process of nymph; *p.sp*, remains of the posterior spiracles of larva. (From Gordon Hewitt.)

But a great number fall victims to a parasitic fungus called *Empusa*. Flies killed by this fungus are frequently to be seen in autumn, hanging dead on windows, &c., surrounded by a little whitish, powdery ring of spores formed by the fungus.

Flies, like many other common insects, are extremely difficult to keep alive in captivity, and few have succeeded in rearing them for

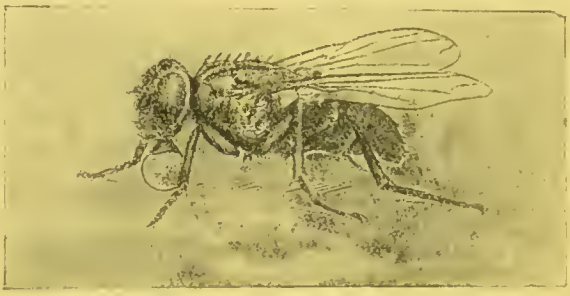


Fig. 20.—*M. domestica* in the act of regurgitating food. × 4½. (From Gordon Hewitt.)

more than a month or two. At one time, as we have said, it was thought that those flies which survive the winter were fertilised females of the younger broods, and that during the winter they subsisted on their 'fat bodies.'

Doubt has recently been thrown on this theory, and in a recent report[1] of the Local Government Board Dr. Newsholme sets forth the results of the researches of Dr. Monckton Copeman and Mr. E. E. Austen in the following words :—

[1] New Series, No. 102.

Until recently there was general agreement that a certain number of flies managed to survive the winter and spring by hibernating in dark nooks and crannies in dwelling-houses, or, as contended by Dr. Laver,[1] in various sheltered situations outside dwellings—such as the under-surface of the thatch of farmyard stacks. The researches of Mr. Jepson and others have shown that, during the period extending from late autumn to early summer, flies may be found occasionally in all active conditions in warmed houses, and especially in such places as kitchens and bake-houses, where the temperature is kept relatively high; and further, that under these conditions, and in presence of sufficient food material they may even continue to breed. Doubt has, however, been expressed as to whether a sufficient number of flies remain in active condition in these localities to perpetuate the species and to start the rapidly multiplying generations of the following summer. As to whether flies can persist through the winter in other than adult form practically nothing is known.

In view of the importance of obtaining further information on these points, some inquiries were undertaken into the hibernation of flies, the results of which were set out in a communication by Dr. Copeman published in the sixth report of this series. Arrangements were made with a working naturalist for the collection of any flies that could be found in situations like those which Dr. Laver and other observers had found to be favourite winter quarters

[1] *Reports on Public Health and Medical Subjects* (New Series), No. 85, pp. 15 and 16.

of hibernating flies. In view of the need, pointed out by Howard, for expert identification of the species of all flies captured in a dormant condition during the winter months, the co-operation of Mr. Austen of the British Museum (Natural History) was obtained, and to him all the flies collected were submitted for examination. The one specially interesting and unexpected point emerging from this inquiry was that not a single specimen of the house-fly (*Musca domestica*) was met with among the considerable number of hibernating flies caught in situations which have hitherto been regarded as the special habit of this fly. Under these circumstances it was felt that further detailed investigation of the matter was needed; and, accordingly, inquiry on a more extended scale, and covering—as it proved—an extensive area, was initiated and carried through during the past winter.

. . . . . .

Once more, the results obtained afford no support to the belief that house-flies hibernate, in this country, in the adult state; and the problem as to the manner in which the interval between one fly-season and the next is bridged over still remains unsolved.

Gordon Hewitt, Copeman, Howlett, Merriman,[1] and others, have made experiments as to how far a fly can travel. Marked flies have been taken within forty-eight hours at distances ranging from 300 yards to a mile.

[1] One of the first to fall a victim in defending the South African Federation against De Wet's rebellion.

Apparently the direction of the wind plays a considerable part in the distance they travel.

The importance of the house-fly as a carrier of disease, especially bacterial disease, has recently been recognised especially in times of war. Moses was as great as a Principal Medical Officer as he was as a Director of Supplies; and this is shown in Deuteronomy, chapter xxiii, where he deals with the need of strict hygiene in the camp.

In the middle of the last century already attention was being drawn to the fact that the house-fly and the blow-fly transmitted various diseases. But it was during the Spanish-American War and the South African War which followed shortly afterwards that the part played by these pests in conveying enteric became definitely established. Flies coming straight from the latrines, with their legs and their wings and their proboscides soiled with typhoid bacilli, would enter the camp and the tents of the soldiers and settle on their food-supplies—crawling over their jam, floating in their milk. Thirty per cent. of the deaths in our South African War were due to typhoid fever. The bacillus, as is well known, is capable of existing for a long time and of persisting alive in the alimentary canal of the insect. Dr. Graham-Smith has shown that the bacilli may remain active for six days after

feeding, and that the feet of flies which have the bacillus on them are capable of infecting surfaces upon which they walk for at least two days after first coming in contact with the germs that cause 'enteric.'

Faichne reared maggots in dejecta infected with typhoid bacilli, and he was able to show that the flies into which these maggots turned

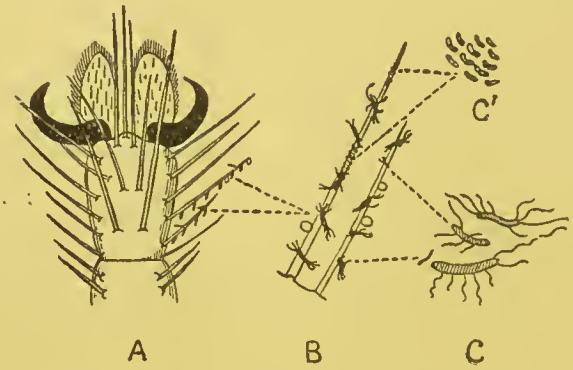


FIG. 21.—A, Foot of a fly, showing hairs bearing bacteria; B, a single hair more highly magnified; C and C', bacteria. Diagrammatic.

contained virulent typhoid germs in their intestines. There is absolutely no doubt that typhoid is largely conveyed by the agency of these insects; and as flies are perfectly controllable, if 'the people will but have it so,' it is one of the disgraces of our civilisation that this disease should be so prevalent.

The protective inoculation against enteric is now almost perfect, and its value is shown by

quotations from a leaflet issued by the Research Defence Society :—

Sir William Leishman, in a letter published during the present war, August 22, 1914, says: 'The benefits of inoculation are so well recognised in the regular forces that we find little difficulty, in foreign stations, in securing volunteers for inoculation : for instance, about 93 per cent. of the British garrison of India have been protected by inoculation ; and typhoid fever, which used to cost us from 300 to 600 deaths annually, was last year responsible for less than 20 deaths. Inoculation was made compulsory in the American army in 1911, and has practically abolished the disease ; in 1913 there were only 3 cases, and no deaths in the entire army of over 90,000 men.

In Avignon, in the south of France, during the summer of 1912, typhoid fever broke out in the barracks. Of 2053 men, 1366 were protected and 687 were not. The non-protected had 155 cases of typhoid, of whom 21 died ; the protected had not one case. In the winter of 1913 the French Senate resolved that the protective treatment should be made compulsory throughout the French army ; and, in special circumstances, among the reservists.

Infantile diarrhoea, which so afflicts the crowded, poorer quarters of our cities in the summer, is another disease intimately associated with *Musca domestica.* But that is hardly a disease likely to trouble the soldiers. The tubercle bacillus is another germ conveyed by

flies. House-flies are particularly fond of feeding on saliva; and Hayward, Lord, and Graham-

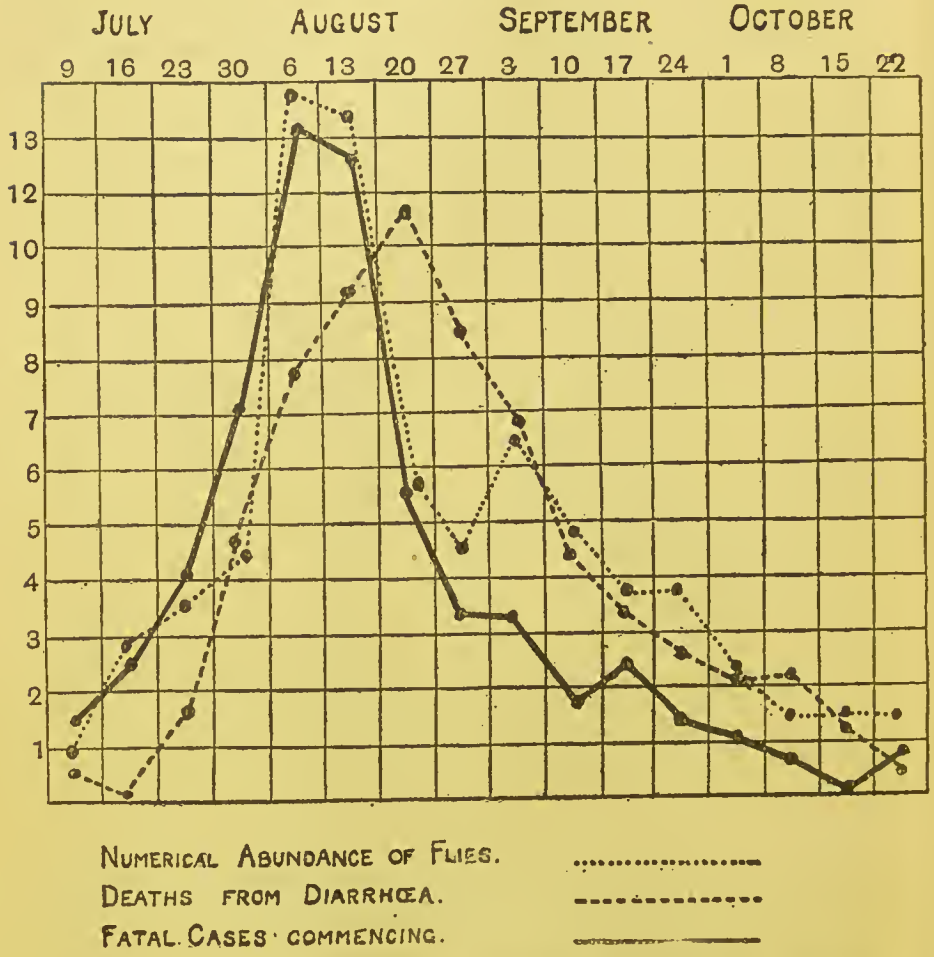


FIG. 22.—Chart illustrating the relation of the numerical abundance of house-flies to summer diarrhoea in the city of Manchester in 1904. Prepared from statistics and chart given by Niven. (From Gordon Hewitt.)

Smith have obtained virulent bacilli from the intestines and dejecta of flies which had been fed on tubes containing tuberculous sputum.

These experiments have been amply confirmed by other workers. Anyone who has ever been in Egypt will remember the terrible sight of the flies attacking little children suffering from ophthalmia and it is believed that the wide prevalence of this most pitiful trouble is attributable to the abundance of flies—the flies of Egypt, a plague even in the times of the Pharaohs. Things do not alter much in Egypt, and the Biblical plagues are wont to recur.

Another disease—anthrax, or wool-sorter's disease—may be conveyed by the same carriers from infected cattle to man, and there is a good deal of epidemiological and bacteriological evidence available to show that flies play an important part in the spread of cholera, which is now threatening the soldiers in the eastern seat of the war, and possibly in disseminating the organisms which cause yaws and tropical sore.

It will be noticed that the fly is not a necessary second host for any of these germs. They are conveyed, as if by an inoculating needle, by contact with the proboscis or the legs or some other tainted organ of the fly. The bacilli, however, pass through the alimentary canal apparently unchanged and unharmed, and are deposited either with the regurgitated food from the fly's stomach (Fig. 20), or with the dejecta of the insect. There is no subcutaneous

inoculation—such as takes place in the case of the mosquito when it conveys malaria, or in the case of the tsetse-fly when it conveys sleeping sickness—where the disease-causing organism is injected into the human body. The action of the fly is mechanical, but none the less efficient. The poisoning of the soldiers' food-supply is its chief rôle in war.

CHAPTER VI

FLIES

Part II

THE BLUE-BOTTLE (*Calliphora erythrocephala*), AND OTHERS

Who fills our butchers' shops with large blue flies ?
(*Rejected Addresses.*)

But there are other flies : first amongst which may be mentioned *Fannia canicularis* and *F. scalaris*. These belong to the family known as Anthomyidae, and are distinguished from the house-fly by being smaller in size, and by many other small details in the imago stage hardly to be appreciated except by trained dipterologists. For a short time at the beginning of the summer, during part of May and June, specimens of *F. canicularis* are more abundant than *M. domestica*, and, when seen on the window-panes of our living-rooms, are apt to be thought, by the uninformed, to be young specimens of the latter. But, as has been said, flies, when they are once flies,

do not grow; all the growing they do is done in the larval stage. As the days lengthen the common house-fly becomes vastly more common than *F. canicularis*, the 'lesser house-fly,' and the latter now tend to aggregate in those rooms of our houses not devoted to cooking, and may frequently be noticed flying in a jerky and disconcerting manner around the chandeliers or bedposts in unfrequented living- or bed-rooms. The relative proportion of these two genera in full summer varies in different localities. Roughly speaking, out of 100 flies collected in a house there is something between 90 and 99 per cent. of *M. domestica*, but the numbers not only vary with locality, but with temperature.

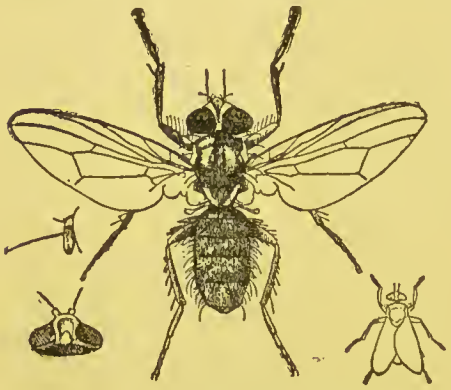


FIG. 23. — Latrine-fly, *Fannia scalaris*, male (× 3). Antenna. Head of female, dorsal view. Natural size, resting position. (From Graham-Smith.)

On the other hand, there is a curious disproportion between the number of sexes found 'at home' in the lesser house-fly. For every 100 *F. canicularis* taken indoors seventy to seventy-five are males, the numbers being evened by an equal preponderance of females

who have remained out of doors. The larva of *Fannia* is a flattened-looking grub with distinct segments, decorated by numerous feathery processes. It lives amongst decaying vegetation and fruit, and also amongst fermenting animal matter and dejecta. Sometimes it is found in rotting grass. As we shall see later, it frequently passes into the human alimentary canal.

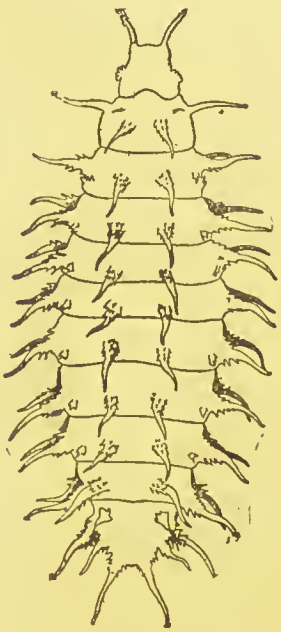


Fig. 24.—Larva of *F. canicularis*. (From Gordon Hewitt's Report to Local Government Board, 1912.) Magnified.

F. scalaris, usually known as the 'latrine-fly,' is even commoner than its congener, and the external structural differences are minute. As its name indicates, it is found as a rule breeding in human dejecta, and is, therefore, as a typhoid carrier, much more dangerous than *F. canicularis*. Its larva is also more commonly found in the human intestine.

Then there are two species of large flies known as blue-bottles or blow-flies—*Calliphora erythrocephala* and *C. vomitoria*. The former of these is the more common. The sides of its face are golden yellow, set with black hair; whereas in *C. vomitoria* the sides of the face

are black, but the hair is golden. Both are handsome, sturdy-looking diptera, with bluish-black thoraces, and abdomens of a dark metallic gun-metal sort of colour.

Blow-flies deposit their eggs on fresh or decaying flesh, and this is one of the great

Fig. 25.—Blow-fly or blue-bottle, *Calliphora erythrocephala*, female (× 3). Antenna. Male head, dorsal view. Side view of head. Natural size, resting position. (From Graham-Smith.)

sources of trouble to the officers of the Army Service Corps. But they are not content with killed flesh. They will lay their eggs on any living flesh which is exposed, or in sores or tumours, and here their larvae will thrive. Dr. Graham-Smith tells us he once found the exposed muscles of the broken leg of a living rabbit seething with a mass of small blow-fly

larvae, which were nourishing themselves upon the living tissues.

The eggs of the blow-fly hatch out in from ten to twenty hours in normal British temperatures; the larval life, in its three stages, lasts from seven to eight-and-a-half days; the pupa state lasts a fortnight, so that the total development extends a day or two over three weeks. The maggots are unusually voracious; and Linnaeus used to say that the progeny of three blow-flies will dispose of a dead horse as quickly as three lions.

C. erythrocephala is essentially an outdoor fly and enters houses only in search of a nidus on which to deposit its eggs. *C. vomitoria* resembles its congener in size and habits, but it is not so abundant. Occasionally its eggs have been known to be deposited in the nostrils of animals and men.

But there are :—

> All species of resplendent flies,
> Some with green bodies and green eyes,
> Pricking like pins' heads from their holes
> Like tiny incandescent coals.
>
> (Anon.)

One of these, *Lucilia caesar*, is a marked nuisance to those responsible for victualling a camp. This 'green-bottle' fly, like the *Calliphora* and the house-fly, belongs to the family Muscidae, and its larvae are said to be

indistinguishable from those of blue-bottles. Some species of *Lucilia* deposit their eggs in great quantities amongst the wool of sheep when the sheep are ill-kept, and they do much damage. But as far as war is concerned the harm that *Lucilia* does is laying its eggs upon dead animals. It does this

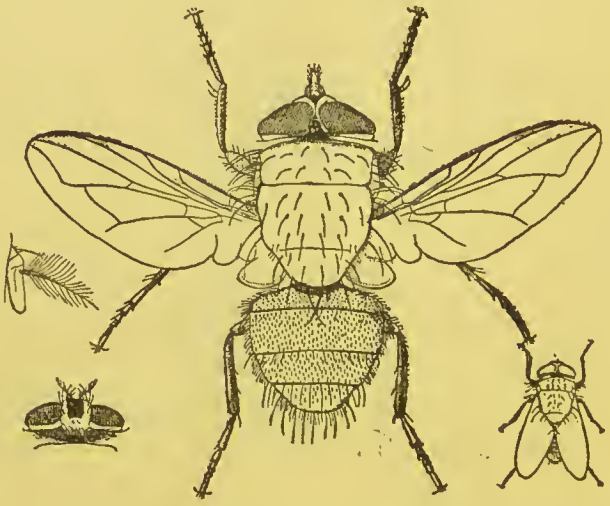


Fig. 26.—Green-bottle, *Lucilia cæsar*, male (× 3). Antenna. Female head, dorsal view. Natural size, resting position. (From Graham-Smith.)

on all sorts of meat-stores; but in times of peace it especially infests stale fish, which the issuing larva very soon eat clean to the bone. When feeding upon a dead fish lying upon a beach they burrow down in the sand below their food. They descend some two to six inches, and for the most part remain deep in the sand during the daytime, coming

up to feed at night. They also have a habit of migrating from one fish to another. This fly has also been known to lay its eggs in the neglected wounds of human beings.

Sarcophaga carnaria is another species which occasionally infests human sores, and which

Fig. 27.—Flesh-fly (*Sarcophaga carnaria*), female (× 3). Antenna. Natural size, resting position. (From Graham-Smith.)

enters houses in search of filth or carrion on which to deposit its larvae, for it is viviparous and produces not eggs but live larvae. One female can give birth to 20,000 young; and Redi states that the larvae of these flesh-flies will in twenty-four hours devour so much food and grow so quickly that they increase their weight two-hundredfold.

Finally, there is a group of flies whose larvae penetrate under the skin of human beings and give rise to definite subcutaneous troubles. But, fortunately, these are, with few exceptions, confined to the warmer regions of the earth, and there is very little risk of their causing real trouble in Northern or Central Europe.

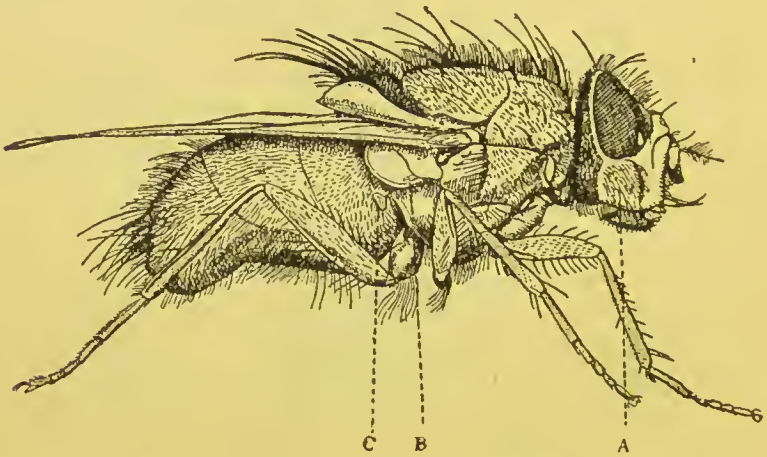


FIG. 28.—Side view of blow-fly (*Calliphora erythrocephala*) (× 5). A, Cheek (jowl); B, squama; C, halter. (From Graham-Smith.)

The troubles or diseases caused by the presence of fly larvae in the body are grouped in medical language under the term 'myiasis,' which Graham-Smith defines as follows :—

'The term myiasis signifies the presence of dipterous larvae in the living body (whether of man or animals), as well as the disorders (whether accompanied or not by the destruction of tissue) caused thereby. Though not strictly

coming within this definition, the sucking of blood by larvae through punctures of the skin, which they themselves produce, may be included for the sake of convenience in classification.

Myiasis in man may be produced by dipterous larvae :—

(*a*) Sucking blood through punctures in the skin (*Auchmeromyia luteola*).
(*b*) Deposited in natural cavities of the body (*Chrysomyia*, *Lucilia*, *Sarcophaga*, *Calliphora*, *Oestrus*).
(*c*) Deposited in neglected wounds (*Chrysomyia*, *Lucilia*, *Sarcophaga*, *Calliphora*).
(*d*) Living in subcutaneous tissue (*Cordylobia*, *Dermatobia*, *Bengalia* (?), *Hypoderma*).
(*e*) Passing through the alimentary canal (*Fannia*, *Musca*, *Eristalis*, *Syrphus*, *Gastrophilus*).

In the above list, only the more common genera producing myiasis are mentioned. In England, Type (*e*) is fairly common, and Types (*b*) and (*c*) are occasionally observed.'

We may now consider in detail, but very shortly, the categories set forth by Dr. Graham-Smith :—

(*a*) The very peculiar blood-sucking maggot known as the Congo-floor-maggot—the larva

of *Auchmeromyia luteola*—fortunately does not spread beyond tropical and sub-tropical Africa. It chiefly affects the natives who sleep on mats.

(*b*) The flies which deposit their ova and larvae in the cavities of the body are again mostly foreign. The worst of all is the screw-worm (*Chrysomyia macellaria*) of the Southern States, Central and South America. Although it extends to Canada it is not troublesome north of Texas.

Occasionally, blow-flies in Great Britain deposit their ova in the human nose or ear. They very rapidly hatch and cause great inflammation and necrosis until they can be discharged or removed. They have even been found in the anterior chamber of the eye; and I have some microscopic sections showing the presence of these larvae in that chamber, whither they had probably proceeded from the nasal sinuses. But on the whole, cases of this sort are comparatively rare, and cause but little trouble.

(*c*) The real difficulty, and one which late last summer proved a serious trouble to our army in the field, are the cases in which maggots were found in neglected wounds. Here, however, we may take some comfort in the fact that the trouble is fortunately much greater in the tropical and sub-tropical regions than in more temperate climates, and diminishes

as the cold weather draws on. Still, during the hot weeks of last August there were cases of wounded soldiers left lying on the fields for two or three days who were found to be suffering in this way. One almost hesitates to offer suggestions to our heroes in such cruel conditions; but whenever and wherever it can be done wounds should as far as possible be kept covered.

Wounds or sores which are infested by fly-maggots may be treated in the following ways, but the treatment should be prompt and thorough. The infected wound or sore should be irrigated with a 1 in 20 carbolic solution, or swabbed out with pure benzine. Tumours which result from the presence of these larvae should be freely opened and the contents expressed, and the cavity thoroughly irrigated. Tobacco-juice has been effectively used in some tropical countries where other remedies were not available.

Dr. J. H. Strachan has been good enough to write to me as follows :—

> . . . In Colombo, where the moist heat averages 82 F., any animal getting sores is very quickly fly-blown. The wound soon becomes a mass of writhing maggots—i.e., if it has escaped human attention, and is out of reach of licking. Such spots are often eaten down to the bone in dogs and horses ; but such cases can be cured practically at once by injecting Margosa

oil. Apply the oil by dropping or squeezing it in, and immediately all the maggots will start out of the wound.

This oil, which can be bought at any Eastern bazaar, is the product of the Margosa-tree, *Azadirachta indica* (Meliaceae), and has a great reputation amongst the natives not only as an application to suppurating scrofulous glands, but as an antiseptic which drives away the maggots; and at times it is administered internally, as an anti-helminthic. The Margosa is a handsome tree some forty-five feet high; it is called by the natives *Nim*, and by the Portuguese *Margosa*, and extracts from its bark are used as tonics. The only disadvantage of Margosa oil is that it is said to have an exceptionally unpleasant smell, which might militate against its use in an open hospital.

Not only are neglected wounds affected, but tumours and ulcers are often attacked. But, as I have said, the danger is much greater in warmer climates. We know that Herod Agrippa 'was eaten of worms, and gave up the ghost': a fact which recalls the translation given by an undergraduate in difficulties with the Acts of the Apostles in the 'Little-Go' who rendered 'καὶ γενόμενος σκωληκόβρωτος ἐξέψυξεν' 'He became a Skolekobrote, and died in the enjoyment of that office.'

(*d*) Flies burrowing in the subcutaneous

tissues are again very much commoner in tropical climates than in Northern Europe, and the cases quoted in our country are comparatively rare.

(*e*) The presence of larvae in the alimentary canal of man is by no means uncommon. Both the larvae of *Musca* and *Fannia* are not infrequently found; and over a thousand of the latter have been passed by a highly infected individual at one time. They probably make their way into the body with over-ripe fruit. In some cases they give rise to no symptoms, but in others violent pains are felt and a certain dizziness, and the digestive functions are interfered with. The presence of these larvae in the urinary passages is even more difficult to explain, but they undoubtedly are at times found in these channels.

A few years ago an elaborate investigation was carried on by Mr. W. Nicol, for the Local Government Board, on the part played by flies in the dispersal of the eggs of parasitic worms. He showed quite definitely that the ova of certain human parasites are taken into the fly and pass through its body undigested. Should these be deposited on the food of man, there is great risk of his becoming infected. As I have said before, flies take only liquid food, and it is only when the

ova of the parasites are very small that they can pass into their alimentary canals. Some eggs are too large for the fly to swallow. Eggs of parasitic worms have also been shown to be carried on the legs and proboscides of flies, and these are deposited on the spot where the fly next cleans itself. Probably, however, in the end little harm is really done by flies in disseminating parasitic worms, but it is a possibility which must not be altogether disregarded.

The remedial measures for the control of flies are fully dealt with in Graham-Smith's admirable book, 'Flies in Relation to Disease,' from which I have ventured to borrow many figures; and again by Dr. Gordon Hewitt, in his work on 'House-flies,' which has had such a wonderful success in stimulating our North-American cousins to decrease the numbers of one of the gravest enemies to mankind.

It has been shown over and over again that we can control the mosquito. We have done it at Ismailia, at Port Swettenham, and elsewhere, and the Americans have done it in the Panama zone. We could equally control the 'Infinite Torment of Flies.' The Canadians and Americans are doing their best; but are we? The knowledgeable world has at least discovered the reason why Beelzebub was called the 'Lord of flies.'

CHAPTER VII

MITES

Part I

THE HARVEST-MITE (*Trombidium*)

Natura in minimis maxime miranda.

(Linnaeus.)

We cannot define Life. The cynic who tried, and said '*It's just one damned thing after another*,' got very near one of the aspects of life which we all appreciate; but not very near a physiological definition, for in truth we do not know what life is. But we can at any rate record its manifestations; and we know that it is always associated with an extremely complex substance called by Purkinje 'protoplasm.' This substance Huxley described as 'the physical basis of life.' Protoplasm, though we know of what elements it is composed, defies accurate analysis, and, indeed, is never the same for two seconds together. It is constantly

changing, it is in a state of flux and is, in effect, a stream into which matter is continuously entering and continuously leaving.

Protoplasm may be living, or it may be dead, and when dead it soon undergoes dissolution, but there is no life without protoplasm. Somewhere or other Dr. David Sharp has stated that of the total amount of protoplasm 'in being' in the world—the active volume of the life-material of our globe—at least one-half is wrapped up in the body of insects. But insects only form one sub-group out of the several which make up the great group *Arthropoda*, or those animals which are distinguished from the others by possessing externally jointed legs—that is, jointed appendages. This group includes also the Crustacea, the multi-segmented Centipedes, and the Arachnids or spider-like animals.

Insects, like aeroplanes, dominate the air; Crustacea, like submarines, inhabit the water. The poet has passionately asked :—

> Ah ! who has seen the mailèd lobster rise,
> Clap her broad wings and soaring claim the skies ?

But the answer, in the language of those curious mammals the politicians, is 'in the negative.' Crustaceans are essentially aquatic. On the other hand, centipedes and spiders (Arachnids) are earth-loving animals, but some

have unhappily developed parasitic or pseudo-parasitic habits.

The last-named sub-group, the Arachnids, comprise many subdivisions. There are the spiders, the harvest-men, the scorpions, the king-crabs, and so on. But one of the most numerous of the subdivisions of the group are the mites and ticks (*Acarina*). I have for years been trying to find some organ or structure shared by insects and mites and ticks, and not found in any other group of arthropods. If I could do this I would invent a long polysyllabic word—with lots of Greek in it—which would really be a short way of designating those arthropods which convey disease to man.

Fig. 29—*Trombidium holosericeum.* Female, dorsal view. × 20. (After Railliet.)

The acarines are for the most part small, and they differ from spiders in having no waist. In fact, the three divisions into which the body of an arthropod is normally divided—head,

thorax, and abdomen—are indistinguishable in mites, the body forming an unconstricted whole. As a rule, these little creatures breathe, as do insects, by tracheae, or, if these be absent, by the general surface of the body. They live for

FIG. 30.—*Leptus autumnalis* = larva of *Trombidium holosericeum*. Ventral view. × 100. (After Railliet.)

the most part on vegetable and animal juices, and their mouth-parts are, as a rule, piercing and suctorial, but in some species the appendages of the mouth are capable of biting as well as piercing. The adults have typically eight legs. The larval stages are very numerous, and at times six distinct moults

of the skin are recognisable. With few exceptions the larva emerges from the egg as a six-legged creature. In fact mites undergo a metamorphosis which varies in complexity and in completeness in different groups, and it is often one of these larval stages which causes the greatest trouble to man.

One of these six-legged larvae has been long known as the harvest-mite, under the name of *Leptus autumnalis*. But this is not a real species, and there is still considerable confusion as to what the exact status of *Leptus autumnalis*, the harvest-mite, is. Probably the larvae of several species are involved, but it seems pretty certain that in many cases the larvae will grow up into specimens of *Trombidium holosericeum*, though a certain and at present unknown percentage of the larvae will grow up into *Trombidium something-or-other-else*.

They are minute bright-scarlet little creatures—the Cardinals of the Mite world—of a beautiful satiny red, decorated here and there with blackish spots. The body of the adult is somewhat square, tapering slightly to the hinder end. Both legs and body are covered with red hairs. The eyes are borne on little stalks—like lighthouses. The legs have six joints and end in two little claws. The male is usually smaller and more feeble than the female, the latter reaching a length

of 3 mm. to 4 mm. The adults are commonly met with in the spring or commencing summer. They are predaceous, feeding on minute insects and mites. The larval form of this species[1] is undoubtedly one of the forms confused under the now discarded name of *Leptus autumnalis*. When starving, the body is orbicular in outline; but it becomes oblong when it is fed, and in this case it may attain a length of ½ mm. The colour of the larva is of a deep orange.

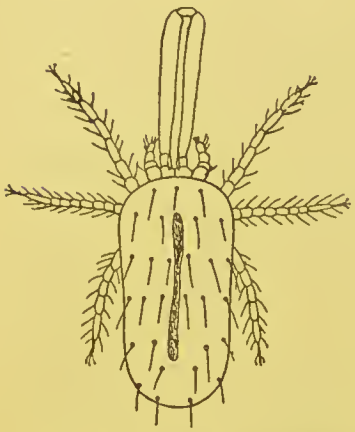


Fig. 31.—*Leptus autumnalis*, with the so-called proboscis. Magnified. (After Gudden.)

This harvest mite, or, as it is called in France, *le rouget*, is most troublesome at the end of summer or at the beginning of autumn. Then is the time when the eggs of *Trombidium* hatch, and enormous numbers of the six-legged larvae, or 'harvest-bugs,' swarm over the grass, ready to attack any warm-blooded animals. Small mammals—such as hares, rabbits, and moles—are often covered with them, but they leave their victim, should it be shot, as soon as the body chills. They are particularly common in Great Britain and in the centre and west of

[1] *T. holosericeum.*

France, and in certain parts of Germany. These irritating little semi-parasites may be dislodged by the application of petrol or benzine—both very inflammable—and the itching they cause allayed by the application of acid or alcoholic lotions.

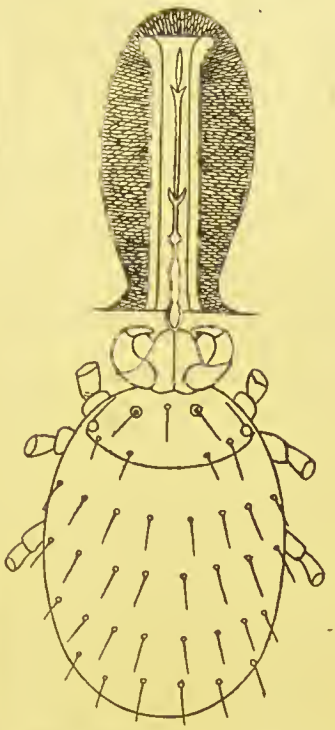


Fig. 32.—*Leptus autumnalis* (× 100). The so-called proboscis is formed around the hypo-pharynx sunk into the skin. (After Trouessart).

Men working in the fields are frequently attacked. During September 1914, the soldiers of the Sixth Division, stationed in and about Cambridge, and living in tents, suffered severely from their 'bites.' They mostly attacked the ankles, the wrists, and the neck, but they rapidly extended over the body. If they be checked by the presence of any stricture, such as a garter or wrist-band, they accumulate behind it, and the irritation is accentuated. The intrustion of their proboscis in the skin caused the surrounding tissues to harden and form a cylindrical tube—the so-called proboscis.

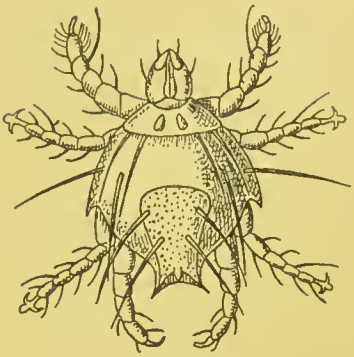
The amount of trouble they cause varies very greatly in different people. Children and women with soft skins suffer, as a rule, most; but, as happens in the case of other biting insects, certain individuals seem to be almost immune, whilst others suffer very considerably. The trouble is caused by the mite implanting its mouth-parts in the skin—preferably in the hair-follicles or the sweat-glands. When it is once fixed it rarely moves. The body remains, of course, on the surface of the skin as a little reddish-orange point, scarcely perceptible unless many of them are congregated in the same position. The effect of their presence is to produce a swelling in the skin, which may be as large as a split pea, accompanied by an intense itching and a smarting which banishes sleep. This leads to the patient scratching, and this scratching is the departure-point of many troubles. Scoriated papules appear and eczematous patches, and when the mites are very numerous an erythema, named by Rubies *Erythema autumnale*, supervenes. The skin near the point of puncture swells, becomes red, sometimes almost purple, and irregular patches, which, when confluent, may be a centimetre in diameter.

These skin troubles, which may end in a kind of generalised eruption, are accompanied by a rise of temperature and a certain

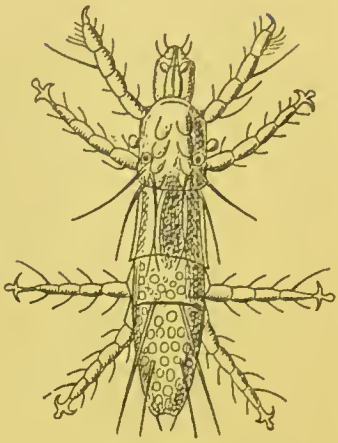
—sometimes a high—degree of fever. Besides men, dogs and cats suffer from these pests ; and in these domestic pets the parasites give rise to a miliary eruption. Domestic cattle—sheep and horses—are also attacked. And, according to some authorities, poultry are not only attacked but killed by these parasites. The larvae apparently only live for a few days on the skin of the victim.

As far as is known at present the larvae of *Trombidium* convey no protozoal disease ; but there is a terrifying little creature, known as the Kedana mite, which in some districts of Japan causes a serious illness, with a mortality of some 70 per cent. Apparently, it does not act as an inoculating agent itself, but the papule, surrounded by the red area which forms as a result of its bite, changes to a pustule, and this lesion becomes the point of entrance of bacteria which produce the so-called 'river' or 'flood' fever. If these mites be carefully removed the patient suffers no harm.

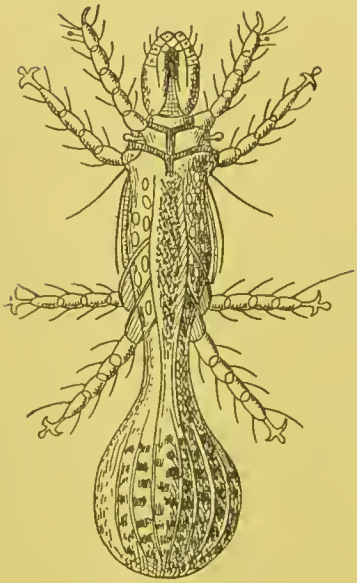
Another species of mite, *Pediculoides ventricosus*, lives in stalks of cereals, and is very apt to attack labourers who are dealing with grain. Their bites cause severe irritation, local swellings, reddening of the epidermis, and fever. In this particular species the female before she is fertilised has an elongated form 0·2 mm. in length and 0·07 mm. in



(Male)



(Female)



A

B

Fig. 33.—*Pediculoides ventricosus.* Male, ventral view (× 250). Female, before fertilisation (× 225). A, after fertilisation; the abdomen has begun to swell (× 250). B, with abdomen fully swollen (× 40). (After Laboulbène and Mégnin.)

breadth ; but when fertilised the ovaries increase to such an extent that the posterior end of the body becomes spherical. In this respect it resembles that remarkable flea, the chigo or jigger. The larvae are exceptional in being born with eight legs instead of the usual six. They pair almost immediately after emerging from the egg-shell.

CHAPTER VIII

MITES

Part II

ENDO-PARASITIC MITES (*Demodex, Sarcoptes*)

> Say what the use, were finer optics giv'n,
> T' inspect a mite, not comprehend the heav'n.
> (Pope, *Essay on Man.*)

Demodex

We have seen that harvest mites are wont to insert their heads—or rather their mouth-parts—into the skin of human beings, but other mites show less restraint, and insert their whole bodies. One of these, the well-known *Demodex folliculorum*, is, according to Guiart and Grimbert, 'Le plus commun des parasites de l'homme et nous en sommes presque tous porteurs.' Without taking quite so gloomy a view, *Demodex* is undoubtedly widely distributed in the skin of mankind and of other mammals. There are differences of opinion as to whether this form should be split up

into numerous species, or subspecies, according to the genus of the mammals upon which it lives. We, at any rate, will confine our attention to the human kind and so avoid losing ourselves in the tortuous maze of synonymy and the arid discussion of a meticulous classification so dear to the analytical German mind. To us a *Demodex* shall be a *Demodex*, and we will leave it at that.

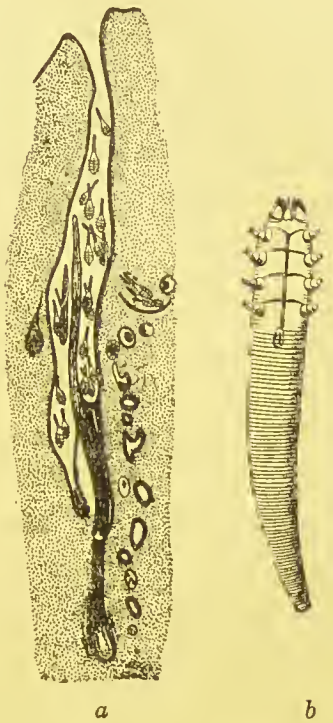


FIG. 34.—(*a*) *Demodex* in hair-follicle of dog; magnified. (After Neumaun.) (*b*) *Demodex folliculorum*; highly magnified. (After Railliet.)

Unlike the majority of mites, *Demodex* is a good deal longer than it is broad. But even for a mite it is very small, and shows signs of bodily degradation associated with its parasitic habit of life. Its shape is adapted to its habitat, which is the sebaceous glands of the skin. The long abdomen appears to be segmented, but the annulations are not true segments. The legs are reduced

to conical stumps. The male is 300 μ[1] long and 40 μ broad across the cephalothorax. The female is, as usual, larger, measuring 380 μ in length by 45 μ in breadth. The minute larvae have, as is so often the case with mites, but three pairs of legs, and are 60 μ to 100 μ in length.

This parasite, which lives on all parts of the skin of the human body, is perhaps most commonly seen on the nose and in the passages leading into the ear. It can be expressed by firmly pressing over the black spot which indicates its presence in the skin of the nose or elsewhere any small cylindrical tube, such as a watch-key. When expressed it is not always easy to see, as coming away with it is a mass of sebaceous matter which can best be dissolved off with oil on the microscopic slide. Whether this particular parasite causes much disease is not known. But in some cases it is certainly associated with acne and other skin disorders; and as it is also found in hair-follicles, it may possibly destroy the hair. It is apparently spread by personal contact.

The Itch-mite

A much more serious trouble is due to *Sarcoptes scabiei*—often called the Acarus—

[1] A μ = 1000th of a millimetre.

which gives rise to the disease known in England as the 'itch' and in France as the '*gale*.' *Sarcoptes scabiei* in both sexes is

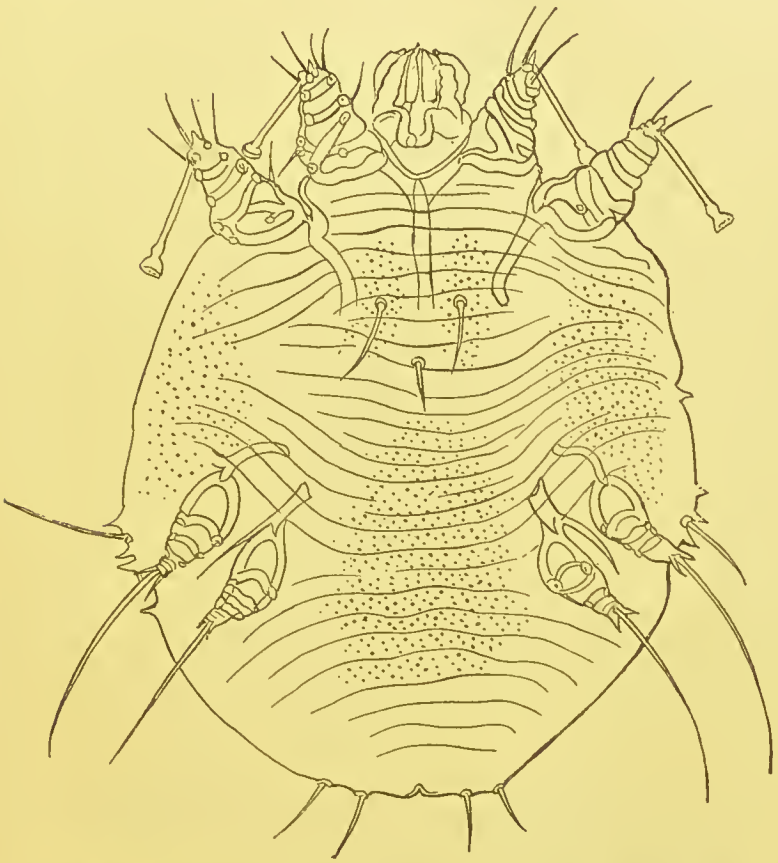


FIG. 35.—*Sarcoptes scabiei*. Female. × 180. Ventral view. (From Bourguignon.)

but little longer than broad. The female is, as usual, larger than the male. These mites are shaped very much like microscopic tortoises, of a pearly grey colour, passing at

parts into a rusty brown. Of the four pairs of legs two run forward close to the head, and two point backwards. The integument

FIG. 36.—*Sarcoptes scabiei.* Male. × 300. Ventral view. The sucker on the fourth leg on the right is accidentally folded over the third leg. (From Bourguignon.)

is semi-transparent and strengthened by parallel folds, and bears many little bilaterally symmetrical protuberances and scales. There are also certain hairs which have some systematic value. The male is usually recognised

by the fact that its third pair of legs terminates in a long hair, whilst the other legs end

Fig. 37.—One of the legs of *Sarcoptes scabiei* (× about 450), showing the stalked sucker and the curious 'cross-gartering.' (After Bourguignon.)

in pedunculated suckers. The male measures 200 μ to 235 μ in length, by 145 μ to 190 μ in breadth. By preference, he lives under the scales which the presence of the parasite produces

on the human host. The female is markedly larger than the male, measuring 330 μ to 450 μ in length by 250 μ to 350 μ in breadth. Her two anterior legs end in stalked suckers, whilst the two posterior end in hairs. The legs, like Malvolio's, are curiously 'cross-gartered' with chitinous bars and rings.

At first she promenades about with the male on the surface of the human skin, but when they have paired the female begins to tunnel in the epidermis. The poor male, having been used, dies. As the mother-mite tunnels she begins to lay eggs, leaving them one by one behind her as she burrows deeper and deeper into the epidermis. Hence those that are nearer the entrance of the tunnel are always more advanced in age and development than those farther in. She always works head forward, and as the cross-section of her tunnel is but slightly bigger than the breadth of her body and markedly less than her length, she cannot turn round, and she is prevented from retreating by the backward hairs or spines of her body. Hence she burrows always forward, until she has dug her own grave at the far end of her excavation.

She is said to live two or three months and to lay one or two eggs a day. Thus one female is, in time, enough to infect seriously a single host. The egg is, relatively to the size

of the mother, enormous: its length being 150 μ and its width 100 μ. The egg is hatched out after three to six days, and the young larva is hexapodous—that is, as is so usual in Acarines, six-legged. It escapes from the burrow on to the skin and soon tunnels into the epidermis of its host, where it moults and transforms, about the ninth day, into a four-

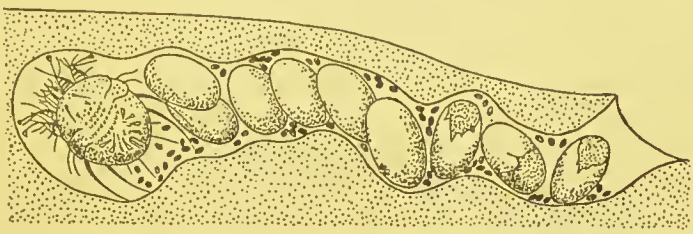


Fig. 38.—A diagrammatic view of the tunnel made by the female of *Sarcoptes scabiei*, with the eggs she has laid behind her as she burrows deeper and deeper. The black dots represent the excrement. (After Guiart and Grimbert.)

legged nymph. At the end of another six days the mites moult again, and at this period one can distinguish nymphs of two sizes: the larger female, and the smaller male.

Within a month after hatching the *Sarcoptes* has become adult, and the sexes are occupied in seeking each other on the surface of the skin, and it is in this stage that they are easily passed by personal contact from one human being to another.

Many animals suffer from *Sarcoptes*; and

the fact that this genus can be transferred to man from the horse, the ox, the sheep, the goat, the dog, the cat, the camel, the

FIG. 39.—A female *Sarcoptes scabiei*, with four eggs in different stages of development; × about 180. (After Bourguignon.)

lion, &c., is a slight argument in favour of their being one species. There is another undoubtedly distinct species which causes serious epidemics, especially in Norway, but

that is hardly likely to enter into the scope of this book.

Sarcoptes scabiei, the itch-mite, is, however, a cause of serious trouble in an army 'in being.' The tunnel or gallery in which the female mite burrows is the only lesion produced directly by the parasite. To the naked eye it presents a little whitish or greyish line, varying in length from some millimetres to one or even three centimetres, the longer ones occurring most frequently on the hands or wrists. It is of course open at one end, and ends in a cul-de-sac, which is slightly swollen, and here it is the female has taken up her abode. She is visible as a small, white, brilliant spot. Besides the wrist, and the inner faces of the fingers—the interdigital areas—the palms of the hands are most commonly affected.

If there is any doubt as to the cause of the existence of these tunnels, a diagnosis can easily be verified by extracting the mite. With the point of a needle, held almost parallel to the skin, the tunnel can be slit open, and when the point has reached the inner end, the female mite, the cause of all the trouble, is very apt to seize it with its suckers, and can be so withdrawn, and, if not, it can easily be picked out. It can then be examined in a drop of diluted glycerine under a microscope.

I am no doctor, hence I venture to refer my readers to the article on Scabies in the 'Encyclopaedia Medica,' by Dr. G. Pernet, and to quote the following paragraphs from Dr. H. Radcliffe Crocker's 'Diseases of the Skin,' third edition, vol. ii. :—

Symptoms and Pathology.—The clinical picture of scabies is made up of two elements: the burrows, or cuniculi, and the attendant inflammation excited directly by the *Acarus scabiei* [1]; and, indirectly, the lesions produced by scratching, and the modifying influences of pressure, friction, &c. The result is a great multiformity of lesions, which, combined with their distribution, is in itself suggestive of the nature of the disease, and enables a practised eye to detect a well-marked case at a glance.

When the skin is first penetrated by the acarus, inflammation is often set up, and a papule, vesicle, or pustule is the consequence. These papules or small vesicles, individually indistinguishable from eczema vesicles, are the most common form of eruption; but the inflammatory symptoms are absent in many burrows. The tract extends and forms a sinuous, irregular, or rarely straight line, which in very clean people is white, but, as a rule, is brownish or blackish from dirt being entangled in the slightly roughened epidermis; the length of these burrows is generally from an eighth to half an inch, but occasionally much longer—Hebra having noticed one four inches long. When a pustule is formed, part of the burrow lies in the roof, but the acarus is always

[1] *Sarcoptes scabiei.*

well beyond the pustule or vesicle; or, if there is none, lies at the far end, and with a lens may often be discerned as a white speck in the epidermis. The degree and number of inflammatory lesions vary much; there may be no inflammation at all about many burrows, or the whole hand—especially in children—may be covered by pustules, vesicles, or papules; and, indeed, a pustular eruption on the hands is always strongly suggestive of scabies; there is, however, no grouping or arrangement of any of the eruptions, as in eczema, the lesions being scattered about irregularly. It must be remembered that burrows are not always present, from various causes. If the disease is recent it may not have got beyond the papular or vesicular stage; while in washerwomen, bricklayers, or others whose hands are constantly soaked in water or alkaline fluids, or who have to scrub their hands violently, the burrows become destroyed. The eruptions due to scratching have already been described in the descriptions of the 'scratched skin,' and comprise excoriations, erythema in parallel lines, eczema, impetiginous or so-called ecthymatous eruptions and wheals, and the inflammatory scab-topped papules often left after the subsidence of the wheals —especially in children. In carmen, cobblers, tailors, and others who sit on hard boards for hours together, pustular and scabbed eruptions, situated over the ischial tuberosities, are so abundant and constant as to be practically diagnostic of scabies in such people. Similar eruptions may be seen where there is friction from trusses, belts, &c.

Treatment.—I use in private practice, after the preliminary soaking and scrubbing, naphthol 15

parts, cret. prep. 10 parts, sap. mollis 50 parts, adipis 100 parts, as recommended by Kaposi, well rubbed in. For infants it can be used half-strength, and I omit the soft-soap. I can speak of it in the highest praise. It is effectual, has no smell, and is not liable to irritate the skin, as sulphur does. It is, however, too expensive for public practice. Nephritis has occurred from its over-use, but I have never seen any bad symptoms. Another remedy less likely to irritate the skin than sulphur is balsam of Peru, of which the vapour alone is said to be fatal to the acari. The balsam is rubbed in for twenty minutes every night ; a night-shirt impregnated with the drug is worn, and in the morning an ordinary soap-and-water bath is taken.

Dr. George Pernet recommends the following treatment for scabies :—

Unguentum sulphuris (H.P.), used in the following way :—

INSTRUCTIONS FOR BATHS

At Night.—Tub with soap and water ; scrub with brush ; rub in ointment and leave on all night.

In Morning.—Bath with plain soap and water.

Note.—The above must be done three nights and three mornings running.

Body- and bed-linen should be sterilised, as also gloves or mittens ; and the inside-seams of cuffs of tunic and coat-sleeves should be hot-ironed.

Flowers of sulphur should be sprinkled in the beds.

N.B.—When Potassa sulphurata is used to make sulphur baths, remember that it spoils utterly all enamelled and metal baths. It also spoils enamelled walls of bath-rooms. Sulphur itself is not soluble in water.

Colonel Allcock says that the best treatment for the itch 'consists in the free use of soap and hot water and the liberal application of sulphur ointment, continued for several days. Some prefer baths of potassa sulphurata (1 ounce of the salt to 4 gallons of water). Clothing and bedding should be fumigated with sulphur or baked.'

Endo-parasitic Mites

Certain little mites whose appearance is as repellent as their name—for they are known as *Nephrophages sanguinarius*—were recorded by two Japanese observers twenty years ago as coming away in the urine of a Japanese patient who was suffering from various bladder troubles. As the mites were in all cases dead, the Japanese doctors thought that they must have been endo-parasites of the kidney. They were found day after day for a week or more, and they were found also in the water with which the bladder had been washed out, but always dead. It is, of course,

possible that the Japanese doctors were right in their surmise, but the best that can be said for the case is that it is 'not proven.' These awful-looking little mites are said to have two large eyes, and legs of five

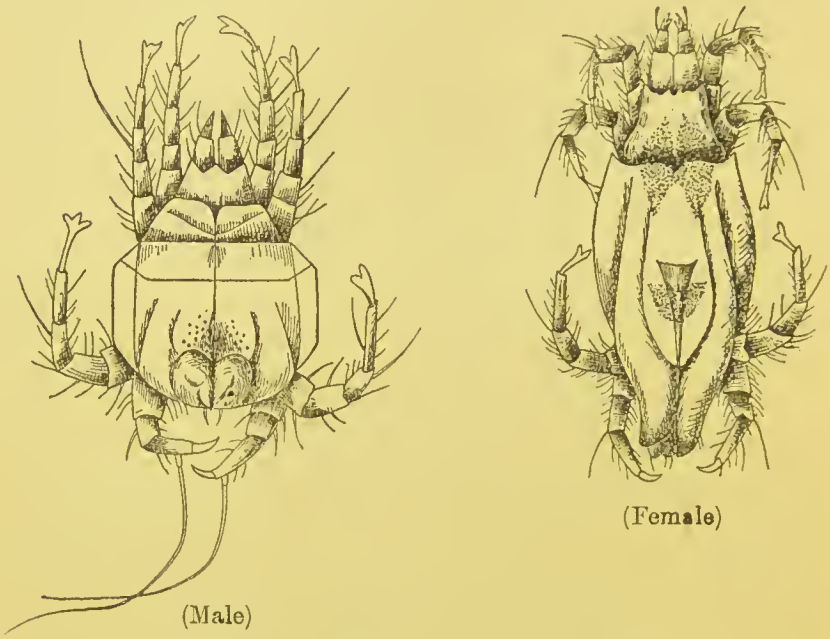


FIG. 40.—*Nephrophages sanguinarius* (enlarged). Male, ventral surface. Female, dorsal aspect. (After Miyake and Seriba.)

segments and of equal length. Their colour is greenish to brownish yellow. Undoubtedly there are many mites which live as endo-parasites. Certain members of the group Analgesinae, such as *Laminosioptes gallinarum*, live in the intramuscular and subcutaneous tissue of fowls, and *Cytoleichus sarcoptioides*

in their air-sacs. I have myself found one of these species in the pigeon, so that it is by no means beyond the bounds of human possibility that *Nephrophages sanguinarius* really lived in the tissues of the Japanese. Very strange things live in the tissues of some Japaneses.

CHAPTER IX

TICKS

A waterleche or a tyke hath neuer ynow, tyl it brestyth.
(*Jacob's Well*, 1440.)

TICKS are mites 'writ large,' and until about the beginning of this century they were regarded with what one might call mild disgust and regret. Now, however, that they have been proved to play a part—and a very important part—in the dissemination of disease, we have come to regard them, as Calverley said we should regard the Decalogue, 'with feelings of reverence mingled with awe.'

The body of a tick is covered with a tough, smooth or crinkled skin, capable almost of any amount of extension. Until they have fed they are flattened in shape, but after a meal of blood they very soon lose the outlines of a Don Quixote and attain those of a Sancho Panza. In the adult, the legs are eight in number and have six joints ending in two claws and sometimes in suckers. Some have eyes and some

have no eyes. The most formidable part of their armour is, however, the mouth-parts, consisting of the tactile pedipalps, and the piercing-probe which they stick into our bodies. This probe consists of two dorsal membranous sheaths, within which play two cutting and tearing chelicerae and a ventral hypostome armed with recurved teeth. When the chelicerae have cut a way into the flesh, the creature begins to suck in blood by means of its sucking-pharynx. Both the teeth on the hypostome and the chelicerae anchor the ticks to their prey.

Fig. 41.—Evolution of *Argas persicus*. 1, the egg; 2, the six-legged larva; 3, the same gorged; 4, an unfed nymph; 5, nymph gorged. (After Brumpt.)

Ticks, as they affect the soldier, may be divided into two families. The first of these, the *Argasidae*, are usually associated with human dwellings, fowl-houses, dove-cotes, and so on, and are more commonly parasitic on fowls than on cattle or human beings. The members of this group hide away in crevices and corners during the day, and come out at night to feed, for 'their deeds are evil.'

Argas persicus, known to travellers as the 'teigne de miana,' is of an oval form, of brownish-red colour. The male measures 4 mm. to 5 mm. in length by 3 mm. in breadth; the female 7 mm. to 10 mm. in length by 5 mm. to 6 mm. in breadth. This creature frequents the northern parts of Persia, and occurs in many other warm countries. In South Africa it is known as the 'tampan' and 'wandlius,' where it is mainly a fowl-parasite. In Persia it is very much dreaded, though probably the effects of its bite are due to the unsuitable treatment the punctured skin receives and the consequent invasion of the tissues by septic bacteria. In South Africa it is frequently fatal to fowls, especially to chickens, but the death is there believed to be due to the loss of blood. It is definitely proved to convey the disease known as Spirochaetosis.

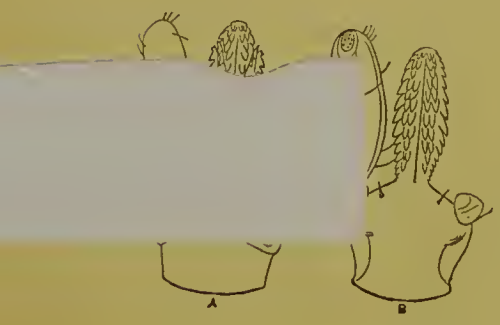


FIG. 42.—*Ixodes ricinus*. Mouth-parts of the female: A, seen from the dorsal, B, from the ventral surface. The median, dotted, portion of the left-hand figure is the sheath; the toothed portion the hypostome. The lateral process is the pedipalp shown only on one side. × 35. (After Nuttall and Warburton.)

We have not yet explained that ticks pass through several stages as they advance from the egg to the adult. The larval stage of *A.*

persicus will remain on its host for five days. It then leaves, and moults in retirement. After the moulting it visits its host by night and remains on it for about twenty minutes. This second stage, known as the 'nymph' stage, moults twice, and the female in each stage becomes much distended with blood—'gorged,' as the saying is. With each moult it becomes

FIG. 43.—*Argas reflexus*, female. On the left the dorsal view of a specimen laying eggs; on the right a ventral view of the same. (After Brumpt.)

larger, but otherwise does not alter much in appearance. The adult female also, like the nymph, visits the host from time to time, and between these visits deposits eggs in great quantities in sheltered crevices—some 50 to 100 being deposited at once. *Argas reflexus*, the 'marginated tick,' is yellow and white—the Papal colours. It is common near dove-cotes and pigeon-houses, and may

attack people sleeping in their neighbourhood. Its bite causes much irritation, and sometimes leads to vesicles and ulcers. At one time it was common in Canterbury Cathedral, and so worried the worshippers that it took all the eloquence of the 'Very Reverend the Dean' to overcome its repellent powers.

FIG. 44.—*Ornithodorus moubata*, an unfed female. To the left a ventral, to the right a dorsal view, showing the crinkled skin. (After Brumpt.)

Ornithodorus moubata, sometimes also known as the 'tampan,' occurs in Tropical Africa, and is a cause of considerable trouble to travellers and expeditions. It occurs normally along caravan routes, and frequently infests native huts. It is catholic in its taste and attacks most mammals, and it has a decided preference for men. In Uganda the natives frequently suffer from its bites—they cause relapsing fever. I myself once

assisted in identifying two ticks, in the nymph stage, taken in Cambridge from the ear of an American visitor to this country, who had been camping out in Arizona shortly before his arrival. This tick turned out to be a species of *Ornithodorus megnini*, which, as a rule, attacks the horse, the ass, and the ox about the ears. But it frequently attacks man, and is well known in the United States, infesting the ears of children. An allied species, *O. turicata*, proves fatal to fowls in the Southern States and in Mexico, and is very harmful to human beings. The chief harm that these ticks do is to transmit protozoal diseases to man and other animals. For an interesting account of these and other protozoal parasites the reader should consult the book, 'Some Minute Animal Parasites,' by Drs. Fantham and Porter.

FIG. 45. — *Ornithodorus moubata*. Female, gorged, seen in profile. (After Brumpt.)

A very few ticks are said to be parthenogenetic, but by far the greater part lay fertilised eggs, and lay them in considerable numbers; and the eggs are agglutinated together in solid little masses, by the sticky secretion of Gené's organ, which opens above the rostrum. The eggs are small and elliptical,

and are laid to the number of many thousands. The young tick, which is usually born with but three pairs of legs, hatches out in a few days if the weather be warm, or a few weeks should it prove cold. A certain amount of moisture must be present, or the eggs are apt to dry up. These masses of eggs are laid on the ground under herbs or grass, or on leaves.

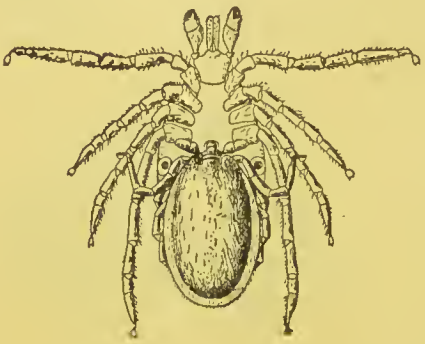


Fig. 46.—*Ixodes ricinus.* The male is inserting its rostrum in the female genital duct before depositing its spermatophore. × 6. (From Brumpt.)

The issuing six-legged larvae, like the young of other animals, are very agile, climbing on to leaves and herbage. They passionately wait with their front legs eagerly stretching out for the passage of the host upon which they desire to settle. Of course, but one in ten thousand succeeds, and it is terrible to think of the amount of unsatisfied desire which must be going on in the tick world! The rest perish miserably. Those that do succeed attach themselves to the skin of the host, and proceed to feed. Having gorged themselves, they usually fall to the earth, but in some cases they remain on the host in a state of inertia

or apparent syncope, and, moulting *in situ*, reattach themselves at once after they emerge as nymphs.

As a rule, however, the gorged larva moults upon the ground, and gives rise to the nymph—an eight-legged creature. This affixes itself anew upon a host, again gorges itself, and in most points resembles the adult, except from the fact that the sexual orifice has not yet appeared. After some days the nymph moults, and then again remains either on the host or it falls to the ground. In some cases there are two successive nymph forms; but as a rule the first nymph gives rise by a second moult to the adult form, which again for the third time regains a host. The adults are now ripe for pairing, and the male having enlarged the orifice of the oviduct by inserting its mouth-parts, deposits therein a spermatophore or capsule full of spermatozoa. The female is often successively fertilised by several males.

In some cases the male dies after fertilisation. The female swells enormously when gorged, sometimes becoming as large as a filbert, or even a small walnut. These ticks are seldom parasites of one particular host, but attack many mammals indifferently. They have some natural enemies: amongst the most important of which are certain Hemipterous

insects whose female attacks the nymphal ticks, and lays within the body of the tick a number of eggs which develop inside the nymph until they reach the adult stage, when they make their escape through an orifice, generally at the hind end, leaving behind them the dead body of their host. Three species of such Hemipterous insects are known to be parasitic on ticks: they are known as *Ixodiphagus*, and in Nature have been found to attack several kinds of ticks which are of economic importance.

Fig. 47.—*Ixodiphagus caucurtei* laying eggs in the nymph of *Ixodes ricinus*. × 20. (After Brumpt.)

Ixodes ricinus, of a brownish colour in the male, is common in many parts of England and, indeed, is almost cosmopolitan. The female is yellow, and flattened, somewhat resembling a grain of rice. It is found on dogs, but it attacks oxen, goats, deer, horses, sheep, and man. It also attacks the grouse, and is particularly common in some parts of Great Britain. It is impossible to rid certain areas of these troublesome guests. In some cases they produce tumours, and their bites may become infected with bacteria. *I. ricinus* conveys the disease 'red-water' to cattle in Europe, the

same being due to a protozoan blood-parasite called *Piroplasma divergens*. *Dermacentor venustus* transmits Rocky Mountain fever to man in certain parts of the States. The fever is accompanied with pains in the joints and in the muscles, and an eruption on the surface of the skin, appearing first on the wrists and forehead, and invading in time all parts of the body, followed by a scaling of the skin during a period of convalescence. In Montana the mortality caused by this disease is very high, varying in different years from 33 to 75 per cent. In Idaho the mortality is far less, only about 4 per cent.

Ornithodorus moubata inoculates man with a spirochaete (*Spirochaeta duttoni*), which is the agent of the African tick-fever or relapsing fever. One of the curiosities about the organisms transmitted by ticks is that they may live through the whole cycle of the tick's life. If they are taken in by the larva they are only transmissible by the following larval stage. They may, however, be conveyed to a new host at the next stage in the tick's development. On the other hand, the parasites may persist in the ticks for several generations.

Think what such a protozoon must have seen! The fertilisation of the tick's egg by the spermatozoon, the fusion of their nuclei, the extrusion of the polar-bodies, the breaking up of the egg into segments, the gradual

building up of the tissues of the larva, the sudden inrush of the host's blood when the larva is safely fixed, the moulting, the changes in the nymph, the development of the generative organs, the formation of the eggs! What a text-book of embryology and anatomy it could write if only it had descriptive powers! If I may paraphrase Kipling :—

Think where 'e's been,
Think what 'e's seen,
Think of his future,
And Gawd save the Queen!

CHAPTER X

LEECHES

Part I

THE MEDICINAL LEECH (*Hirudo medicinalis*)

Hardly anything real in the shop but the leeches and *they're* second-hand. (Bob Sawyer, *The Pickwick Papers.*)

As Mr. W. A. Harding has pointed out, eleven species of fresh-water leeches occur in these islands. But one of these, the *Hirudo medicinalis*, seems to be vanishing, and yet it is just the one we should cherish and preserve.

There are people who do not like leeches. This is shown by the agitation amongst the travellers in an omnibus, as depicted in *Punch* by Leech, years and years ago, when an old gentlemen had upset a bottle of them in their midst. But the medicinal leech, which is our theme, is really the friend of man and of the soldier, and is a beneficial and not a harmful animal. There are, of course, other leeches in our rivers and in our seas, but

of the latter our knowledge is scanty and it is difficult to increase it at present—at any rate, in the Channel or in the North Sea. In any case the marine leeches in our island-waters have no human interest except the influence they exercise on our fish-food supply, and this is practically negligible.

FIG. 48. — *Hirudo medicinalis*; about life size. 1, Mouth; 2, posterior sucker; 3, sensory papillae on the anterior annulus of each segment. The remaining four annuli which make up each true segment are indicated by the markings on the dorsal surface.

Zoologically speaking, leeches are undoubtedly degenerate earthworms (*Oligochaeta*); and some very interesting 'Zwischenformen'—like Mr. Vincent Crummles, I am 'not a Prussian'; but in spite of the war, we may as well employ a useful term captured from the enemy—have been found in Russia and Siberia: forms which combine many of the characters of the *Oligochaeta* and the *Hirudinea*. Possibly the degeneracy which leeches are said to exhibit is associated with a semi-parasitic habit of life. But a semi-parasitic habit does not apply to all leeches—in fact, it applies

but to few genera; there are many others, equally degenerate—if degenerate they be—who have no trace of semi-parasitism.

A curious thing about leeches is that all the varying genera have the same number of somites or segments; and though some of these segments or somites are masked and fused, when analysed by the number of segments in the embryo, by the number of the nerve ganglia, and so on, leeches seem always to have thirty-four such segments. These do not correspond with the rings or annulations so visible on the outside; but a certain number of these annulations, varying in each species, 'go' to each somite, and so constant are these numbers that it would not be very difficult to represent any given species of leech by a mathematical formula.

The known species readily fall into two sub-orders: (1) The *Rhynchobdellae*, which are marine and fresh-water leeches with colourless blood, with no jaws, and with an extensile proboscis; and (2) the *Arhynchobdellae*, which are all fresh-water or terrestrial, with red blood, and generally with jaws. There is no extensile proboscis, and the anterior sucker has a ventral aspect, and is in no way distinct from the body. There are always in this group seventeen pairs of nephridia or kidneys. We shall have mostly to do with the latter sub-order.

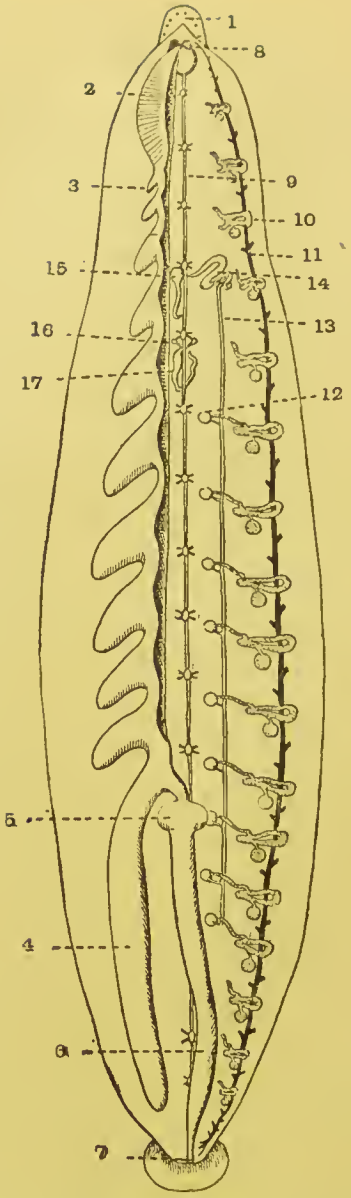


FIG. 49.—View of the internal organs of *Hirudo medicinalis*. On the left side the alimentary canal is shown, but the right half of this organ has been removed to show the excretory and reproductive organs. 1, Head, with eye-spots; 2, muscular pharynx; 3, first diverticulum of the crop; 4, eleventh diverticulum of the crop; 5, stomach; 6, rectum; 7, anus; 8, cerebral ganglia; 9, ventral nerve-cord; 10, nephridium; 11, lateral blood-vessel; 12, testis; 13, vas deferens; 14, prostate; 15, penis; 16, ovary; 17, uterus, a dilatation formed by the conjoined oviducts.

Hirudo medicinalis, the medicinal leech, is found in stagnant waters throughout Europe and the western parts of Asia. It is rather commoner in the southern parts of Europe than in the north. It used to be common enough in England, where at one time, it was bred; but already a hundred years ago its numbers were diminishing.

In a treatise on the Medicinal Leech, published by J. R. Johnson in the year 1816, he records: 'Formerly the species was very abundant in our island; but from their present scarcity, owing to their being more in request among medical men, and to the rapid improvements which have of late years taken place in agriculture—particularly in the draining and cultivation of waste lands—we are obliged to receive a supply from the Continent, chiefly from Bordeaux and Lisbon.' In his time he considered that for every native leech employed at least a hundred foreigners were used.

The same scarcity was very apparent to the poet Wordsworth, whose insatiate curiosity is recorded in the following lines in 1802—Wordsworth was always asking rather fatuous questions :—

My question eagerly did I renew,
'How is it that you live, and what is it you do?'

He with a smile did then his words repeat:
And said that, gathering leeches, far and wide
He travelled; stirring thus about his feet
The waters of the pools where they abide.
'Onee I could meet with them on every side;
But they have dwindled long by slow decay;
Yet still I persevere, and find them where I may.'

In Europe, where the leech was once very abundant, it is now chiefly confined to the south and east; and in Germany it is still found in the island of Borkum and in Thuringia, and ——————; but just now we need not trouble ourselves very much about their distribution in Germany.

In 1842, leeches were occasionally found in the neighbourhood of Norwich, and there are villagers still living in Heacham in Norfolk who remember the artificial leech-ponds. In the middle of the last century the medicinal leeches 'of late years . . . have become scarce.' At about the same time, it is also recorded that they were becoming scarce, though still to be found, in Ireland. Apparently this species is now almost extinct in England, although I know of a naturalist who can still find them in the New Forest, but he will not tell me where. If they were getting scarce in the beginning of the nineteenth century they are far scarcer now[1]—*for there is no leech in*

[1] November 1914.

London—at least, there are only a dozen or two, and they, like those of the firm 'Sawyer late Nockemorf,' are second-hand and I have heard that there is a similar shortage in North America. And yet leeches are wanted by doctors!

Harding tells us that :—

> *Hirudo medicinalis* is not the only leech which has been used in phlebotomy. *Hirudo troctina* (Johnson, 1816), occurring in North Africa and in Southern Europe, where it is perhaps an introduced species, was largely imported at one time for medical uses. . . .
>
> Several other species have been used for blood-letting in different countries. *Limnatis* (*Poecilobdella*) *granulosa* in India, *Liostoma officinalis* in Mexico, *Hirudo nipponia* in Japan (Whitman), and *Macrobdella decora* in the United States (Verrill), are or have been used in phlebotomy.

'Our chief hope seems to lie in India.' These words I wrote in October 1914, and my hopes were justified. Owing to the energy of Dr. Annandale of the Indian Museum, and the anxious care of the authorities of the P. & O. Company, I was able to land, early in the present year, a consignment of many hundred *Limnatis granulosa*—in sound health, good spirits, and obviously anxious to do their duty.

Leeches are still used much more than the public are aware. One pharmaceutical

chemist in the West End of London tells me he sells between one and two thousand a year; and as they were bought wholesale at about one penny each and sold retail at about sixpence, there was some small profit.

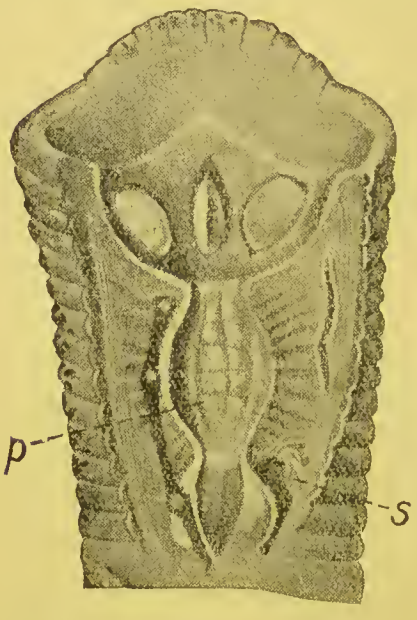


FIG. 50.—Head of a leech, *Hirudo medicinalis*, opened ventrally to show the three teeth and the pharynx *p*, with its muscles; *s*, a nephridium.

Leeches were well known to the ancients, and it would be easy to quote case after case from the classical medical authorities of their use in fevers and headaches and for many ill-defined swellings. They were frequently used for blood-letting where a cupping-glass was out of the question. With his curious uncritical instinct, Pliny records that the ashes of a leech sprinkled over a hirsute area or formed into a paste with vinegar and applied to the part will remove hair from any region of the body. Leeches were also used by the Greek and Roman physicians in angina—especially when accompanied by dyspnoea.

Probably the traffic in leeches reached its

height in the first half of the nineteenth century. Harding reminds us that in the year 1832 Ébrard records that 57,500,000 of these annelids were imported into France, and by this time the artificial cultivation of leeches had become a very profitable industry. Although in a small way leeches may have been cultivated in special ponds in Great Britain, the English never undertook the industry on a large scale. In Ireland the natives used to gather the leeches in Lough Mask, and other inland lakes, by sitting on the edge of the pool dangling their legs in the water until the leeches had fastened on them. But the native supply was totally inadequate, and the great majority of leeches used in this country were then imported. In 1842 Brightwell mentions a dealer in Norwich who always kept a stock of 50,000 of these annelids in two large tanks. The traffic, as we have seen, was very considerable.

The French leech-merchants recognised five classes, as follows :—

1. Les filets ou petites Sangsues, qui ont de un à cinq ans ;
2. Les petites moyennes, qui ont de cinq à huit ans ;
3. Les grosses moyennes, qui ont de huit à douze ans ;

4. Les mères Sangsues ou les grosses, qui sont tout à fait adultes ;
5. Les Sangsues vaches, dont la taille est énorme.

They also recognised many colour-varieties, of which we need only mention the speckled, or German leech—'Sangsues grises médicinales,' with a greenish-yellow ventral surface spotted with black, and the green Hungarian leech with olive-green spotted ventral surface. Both are merely colour-varieties of *Hirudo medicinalis*—a species which shows great variation in colour, and often forms colour-races when bred artificially.

The varying sizes of the five categories mentioned above may be seen by the fact that one thousand of 'les filets' weigh from 325 to 500 grammes, one thousand of 'les petites moyennes' weigh 500 to 700 grammes, one thousand of the 'grosses moyennes' weigh 700 to 1300 grammes, and one thousand of the 'grosses' 1300 to 2500 or even to 3000 grammes. Whereas one thousand of 'les vaches' weigh up to 10 kilograms, and sometimes even more. To increase their weight the dishonest dealer sometimes gives them a heavy meal just before selling them.

They were transported from place to place in casks half filled with clay and water, or

in stone vases full of water. Sometimes they travelled in sacks of strong linen, or even of leather, and these had to be watered from

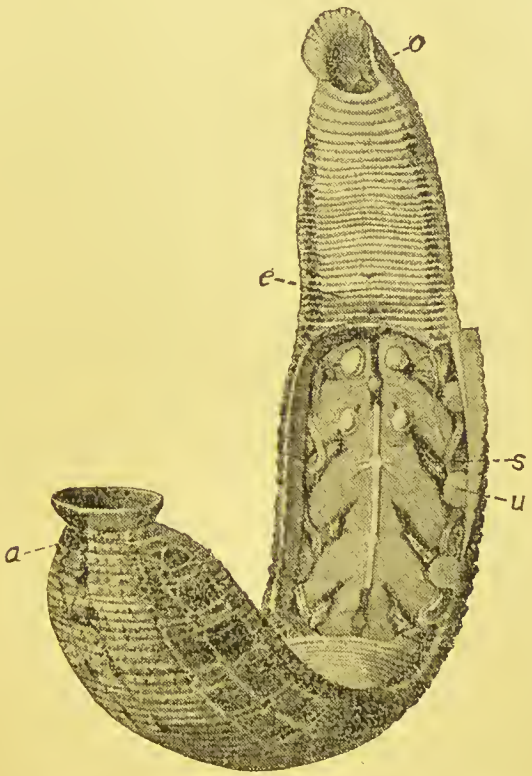


Fig. 51.—*Hirudo medicinalis.* *o*, Anterior sucker covering triradiate mouth ; *e* points to an annulus midway between the male and female openings, *s* to a nephridium, *u* to the bladder of the latter ; *a*, anus. Four testes and four lateral diverticula of the crop are also shown.

time to time. Another mode of conveying them was to place them in baskets full of moss or grass soaked in water, but care had to be taken lest they should escape. These

baskets, again, could not be packed one upon another, or the leeches were crushed. In the old days each sack often weighed 20 to 25 kilograms; and travelling thus, suspended in a kind of hammock, *dans une voiture ou fourgon*, from Palota near Pesth, they reached Paris in from twelve to fifteen days.

They generally travelled via Vienna to Strasburg, where twelve great reservoirs, appropriately placed near the hospital, received them, and here they rested for awhile. Others collected in Syria and Egypt came by ship to Trieste, whence they are sent to Bologna, to Milan, and to Turin, or by water to Marseilles. Marseilles also received directly by sea the leeches from the Levant and Africa, and expedited them to Montpellier, Toulouse, and many another town in the south.

The best time of year for their journey was found to be the spring and autumn. They were more difficult to manage in the summer, and they were all the better for having a rest every now and then, as they used to do at Strasburg. There were times when consignments of from 60,000 to 80,000 a day used to leave Strasburg for Paris. In 1806 a thousand leeches in France fetched 12 to 15 francs; but in 1821 the price had risen to 150 to 200 and even 283 francs. In the latter year they were retailed at 20 to 50 for 4 to 10 sous.

As in England, however, for the most part the artificial cultivation of leeches is diminishing in France, though half a century ago leech-farms were common in Finistère and in the marshes in the neighbourhood of Nantes. There were some years when, if the season was favourable, the peasants carried to market 60,000 a day. Spain and Portugal also furnished leeches for a long time; but by the middle of last century the Peninsula had become almost depleted. But some leeches were still at that period being received from Tuscany and Piedmont. Perhaps the richest fields which still exist are the marshy regions in Hungary.

It will be observed that, probably without their knowing anything at all about it, General Joffre, General von Kluck, Field-Marshal French, the Grand Duke Nicholas, and General von Hindenburg are fighting on some of the best leech-areas in Europe—a point to which we shall return when dealing with the leeches of the Orient.

One wonders what the leeches think of it all!

CHAPTER XI

LEECHES

Part II

THE MEDICINAL LEECH (*Hirudo medicinalis*)—*continued*

Non missura cutem, nisi plena cruoris, hirudo.
(Horace.)

There is no doubt that the medicinal leech is one of the most beautiful of animals. Many of its cousins are uniform and dull in colour —'self-coloured,' as the drapers would call them; but the coloration of the medicinal leech could not be improved upon. It is a delicious harmony of reddish-browns and greens and blacks and yellows, a beautiful soft symphony of velvety orange and olive and black, the markings being repeated on each segment, but not to the extent of a tedious repetition. So beautiful are they that the fastidious ladies who adorned the *salons* at the height of the leech mania, during the beginning of the eighteenth century, used to deck their dresses with embroidered leeches, and by

repeating the design one after the other constructed a chain of leeches which, as a ribbon, was inserted around the confines of their vesture.

Harding tells us that the dorsal surface of *H. medicinalis* is ' usually olive green, richly variegated with reddish-brown, yellowish-green, orange and black, and exhibiting an extremely variable pattern based generally upon three pairs of reddish-brown or yellowish, more or less distinct, longitudinal stripes often interrupted by black ocelli or spots occurring on the last ring of each somite.

' The ventral surface is usually yellowish-green, more or less spotted with black, with a pair of black marginal stripes.'

The shape of the medicinal leech, and indeed of other leeches, is difficult to put into figures, as their bodies are as extensile as the conscience of a politician and as flexible as that of a candidate for parliamentary honours. The length of *H. medicinalis* in extreme extension is said to range from some 100 mm. to 125 mm.; in extreme constriction from 30 mm. to 35 mm. The width in the former state would be 8 mm. to 10 mm., and in the latter 15 mm. to 18 mm.

The movements of the medicinal leech are as graceful as its colour is tasteful. When in the water they move like looper-cater-

pillars (Geometrids), stretching out their anterior sucker, attaching it to some object, and then releasing the posterior sucker they draw the body up towards the mouth. Or, casting loose from all attachment, the leech elongates and at the same time flattens its body until it assumes the shape of a band or short piece of red tape, and by a series of the most seductive undulations swims through the water. Kept in an aquarium they are rather apt at times to leave the water and take up a position on the sides of their home an inch or two above the aqueous surface. When outside the water they keep their bodies moist by the excretion of their nephridia or kidneys. This fluid plays the same part on the skin of a leech as the coelomic fluid of an earthworm, which escapes by the earthworm's dorsal pores. There is very little doubt that both these fluids contain some bactericidal toxin which prevents epizootic protozoa and bacteria from settling on their skins. Such external parasites settle on many fresh-water crustacea—such as *Cyclops*, which is a floating aquarium of Ciliata. In fact, leeches, like earthworms, have a self-respecting, well-groomed external appearance. Like our dear soldiers, they are, so to speak, always clean shaven.

There has been a very widely spread tradition that in their comings and goings

in and out of the water, leeches act as weather prophets. The poet Cowper, who throughout his chequered career ever showed but a very imperfect sympathy with science, tells us that 'leeches in point of the earliest intelligences are worth all the barometers in the world'; and Dr. J. Foster mentions that leeches, 'confined in a glass of water, by their motions foretell rain and wind, before which they seem much agitated, particularly before thunder and lightning.' Modern opinion, however, prefers the barometer.

The great Chancellor, Lord Erskine, kept a couple of tame leeches and Sir Samuel Romilly records the fact in one of his decorous letters :—

> He told us how that he had got two favourite leeches. He had been blooded by them last autumn when he had been taken dangerously ill at Portsmouth; they had saved his life, and he had brought them with him to town, had ever since kept them in a glass, had himself every day given them fresh water, and had formed a friendship with them. He said he was sure they both knew him, and were grateful to him. He had given them different names, Home and Cline (the names of two celebrated surgeons), their dispositions being quite different. After a good deal of conversation about them, he went himself, brought them out of his library, and placed them in their glass upon the table. It is impossible, however, without the vivacity, the

tones, the details, and the gestures of Lord Erskine, to give an adequate idea of this singular scene. He would produce his leeches at consultation under the name of 'bottle conjurers,' and argue the result of the cause according to the manner in which they swam or crawled.[1]

The medicinal leech lives on the blood of vertebrates and invertebrates. Mr. H. O. Latter records that 'cattle, birds, frogs and tadpoles, snails, insects, small soft-bodied crustacea, and worms are all attacked by various species' of leech; but the true food of *Hirudo medicinalis* is the blood of vertebrates. The three teeth, which cause the well-known triradiate mark on the skin, are serrated and sharp. The strong sucking-pharynx has its wall attached by numerous muscles to the underside of the skin of the leech. By the contraction of these muscles its lumen is enlarged, and by thus creating a vacuum the blood of the host flows in.

In the walls of the pharynx and the neighbouring parts are numerous large unicellular glands which secrete an anti-coaguline fluid which prevents the blood of the host clotting, so that even when the leech moves its mouth to another point the triradiate puncture continues to ooze. The same anti-coaguline secretion no doubt prevents the blood coagu-

[1] Campbell's *Lives of the Chancellors*, vol. vi.

lating in the enormous crop of the leech in which this meal of blood is stored. Opportunities for a meal presumably occur but seldom in nature, and the leech is the 'boa-constrictor' of the invertebrate world. Its interior economy is laid out on the basis of a large and capacious storage and of a very restricted and very slow digestion. The blood sucked into the sucking-pharynx passes on to the thin-walled crop, which occupies almost all of the space in the animal. This crop is sacculated, having eleven large lateral diverticula on each side. In a fed leech the whole of this crop is swollen with blood, which, as we have said above, does not coagulate. The actual area where the digestion takes place is ludicrously small, as shown at 5, Fig. 49, p. 138. The rectum, which runs from the real seat of assimilation to the opening of the posterior sucker, transmits the undigested food—but there is not much of it.

An active medicinal leech will draw from one to two drams of blood, and as much more will flow from the wound when the leech moves, because the coagulation of the blood has been put out of action. No scab or clot is formed. If necessary, the flow of blood can be stimulated by hot fomentations. Sometimes the bleeding is so great that artificial means have to be taken to check it. When leeches

are applied to the human integument they are generally first dried in a cloth, and if they will not bite the part required, the part should be moistened with sweetened milk or a drop of blood. To remove leeches when replete, salt, sugar, or snuff sprinkled over the back is used. They may then be made to disgorge by placing them in a salt solution of 16 parts salt and 100 of water at 100° F. A full meal is said to last leeches nine months.

FIG. 52.—Cocoon of the medicinal leech, and longitudinal and transverse views of the same cut open.

Leeches are hermaphrodite; and in some genera the acting male inserts spermatophores, or little cases containing spermatozoa, anywhere in the skin of the leech that is being fertilised, and the spermatozoa then make their way through the tissues of the body of the potential female till they arrive at the ovary and there fuse with the ova. In the medicinal leech the mating is said to be encouraged by adding fresh water to the vessels in which the leeches are living.

The eggs are laid in capsules or cocoons attached to some water-plant or buried in the mud, about twenty-four hours after the leeches have mated. The cocoon is formed,

as it is in an earthworm, by certain glands in the skin which form a secretion that hardens and takes the form of a broad ring, as it were, round the body of the leech.

Through this broad ring the body of the leech is withdrawn and the fertilised eggs are deposited in it. The two ends close up, but not entirely, for the young leeches eventually make their way into the outer water through one of the remaining pores. Within the cocoon are six to twenty ova, and these gradually mature and the young hatch out. When they leave the cocoon they are minute, and of the thickness of pack-thread. More than one cocoon is deposited by each leech, but unless the cocoons are anchored to some submerged object they often rise to the surface of the water and float half submerged, and are then apt to be destroyed by water-rats, voles, and other enemies of leeches. At times the leeches themselves destroy their cocoons.

Fig. 53.—A *Nephelis* forming its cocoon and withdrawing from it.

The exact time of the emergence from the cocoon does not seem to be very definitely known, but leeches are long-lived annelids. It is not till their third year that they are of any use for medicinal purposes, and they

are said not to pair until they are six or seven years old. They certainly live twelve or fifteen years. But, if we adopt an optimistic view—and in this little book we do—the fact that they grow up so slowly and live so long shows that it will be difficult to replace the shortage of leeches in Great Britain and Ireland during the present war. This could hardly be done by home culture, for even if the war lasts three or four years we have lost the cocoons of the summer of 1914, even if we ever had them.

Fig. 54.—Cocoons of *Nephelis*, showing the growth of the eggs and the issuing larvae, which in the lower figure are leaving the cocoons.

Leeches have many enemies:—water-rats, voles, the larvae of the *Dytiscus* beetle, the larvae of *Hydrophilus*, the *Nepa* or water-scorpion, the larvae of the dragon-fly, and the adult *Dytiscus*—all feed upon them. Many birds also eat leeches; and it is recorded that at one artificial leech-farm, where there were 20,000 leeches, they were all eaten up in twenty-four hours by an invasion of ducks. Frogs and newts also devour them, and they are not above eating their own brothers. *Aulostoma* will devour its own species as readily as it will an earthworm.

Those artificially reared, as is usually the case with animals reared in captivity—probably against their will—are peculiarly liable to disease of various sorts. They not only become diseased themselves, but they act as carriers of disease and play the same part

Fig. 55.—A leech-farm in the south of France.

to fish which biting insects play to man and other terrestrial animals. They convey to fishes protozoal diseases similar to those that insects convey to man and other warm-blooded vertebrates.

Leech-farming used to be a profitable undertaking, but now it has fallen into desuetude in these islands. Leeches are, however, still

cultivated in some parts of the world; and in America, Latter describes a farm, situated at Newton in Long Island, where there is, or was, a leech-farm some thirteen acres in extent. The farm consists of oblong ponds of about one and a half acres, each three feet deep. The bottom of each pond is covered with clay, and the banks are made of peat. The French writers recommend, as a rule, the use of clay for the banks. The 'eggs' (cocoons) are deposited in the peat from June onwards, till the weather gets chilly. The adult leeches are fed every six months with fresh blood placed in stout linen bags suspended in the water. A more cruel method of feeding these domesticated leeches is that of driving horses, asses, or cattle into the ponds—and this was the custom in France.

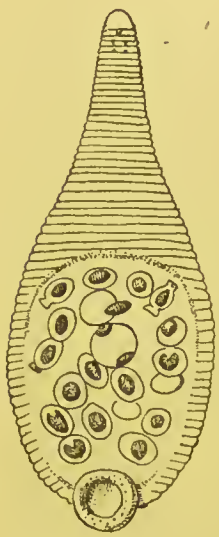


FIG. 56.—*Glossosiphonia heteroclita*, with eggs and emerging embryos. Ventral view. × 4. (From Harding.)

Some leeches show a considerable amount of maternal affection. *Glossosiphonia heteroclita*, for instance, carries its eggs about with it, and *Helobdella stagnalis* has its little young larvae attached by their tiny suckers to the mother's body, which they are loath to leave.

Aulostoma gulo, the horse-leech, is notoriously a very ferocious feeder. Exactly why this species is called a *horse*-leech is a matter of speculation; but 'horse' used as an adjective seems to imply something large and something rather coarse—for instance, horse-chestnuts, horse-play, horse-sense, and horse-laugh.

Fig. 57.—*Helobdella stagnalis*, with adhering young. Ventral view, magnified. (From Harding.)

The rapacity of the daughters of the 'horse-leach' is dwelt on in the Bible.[1] I am not an authority on exegesis, but I have never felt quite sure whether these two ladies were not the offspring of the local veterinary surgeon. But *Aulostoma* does occur in Palestine, and its voracity may very well have been known to the Hebrews. I entirely reject the idea that the word indicates some ghost or phantom: that explanation is due to the craven policy of taking refuge in the unknown.

I conclude this chapter with a couple of sentences taken from Dr. Phillips's 'Materia Medica' on the present use of leeches:—

> The special value of leeching is shown in the early stage of local congestion and inflammations: such as arise from injuries, and in orchitis, laryngitis, haemorrhoids, and inflammations of the ear

[1] Proverbs xxx. 15.

and eye, cerebral congestions, and congestive fixed headache.

Leeches are also of service, in a manner less easy to understand, in inflammations of deep-seated parts without direct vascular connexion with the surface—for example, in hepatitis, pleuritis, and pericarditis, as well as in pneumonia, peritonitis, and, according to some observers, in meningitis. In all these disorders, however, they are very much less used than formerly—in the larger hospitals, for instance, when at one time they cost many hundred pounds annually, a few dozens in the year would represent the total employed.[1]

[1] *Materia Medica and Therapeutics.* By Charles D. F. Phillips, p. 1015.

CHAPTER XII

LEECHES

Part III

EXOTIC LEECHES

(*Limnatis nilotica* and *Haemadipsa zeylanica*).

> Rulers that neither see nor feel nor know,
> But leech-like to their fainting country cling,
> Till they drop, blind in blood, without a blow.
>
> (Shelley, *England in* 1819.)

The extension of war into the Near and Far East has brought into action two genera of leeches which were and still are the cause of extreme inconvenience and even of real danger to troops operating in these areas. The enemies of our Allies will still insist on fighting on richly stocked leech-grounds. For in the new war area, in southern Europe, Asia Minor, Syria, Palestine, Egypt, and parts of India and the real East, two genera of leeches—which are indeed not the friend but the enemy of man, especially of the soldier—abound.

The first of these two is *Limnatis nilotica* (Sav.), and it is from Savigny that I have stolen the picture of this species. It is a leech of

considerable size, attaining a length of 8 cm. to 10 cm., and its outline rather slopes inward at the anterior end. The dorsal surface is brownish-green with six longitudinal stripes, and the ventral surface is dark. It is a fresh-water leech, and it occurs from the Atlantic Islands, the Azores, and the Canaries—its western limit—all along the northern edge of

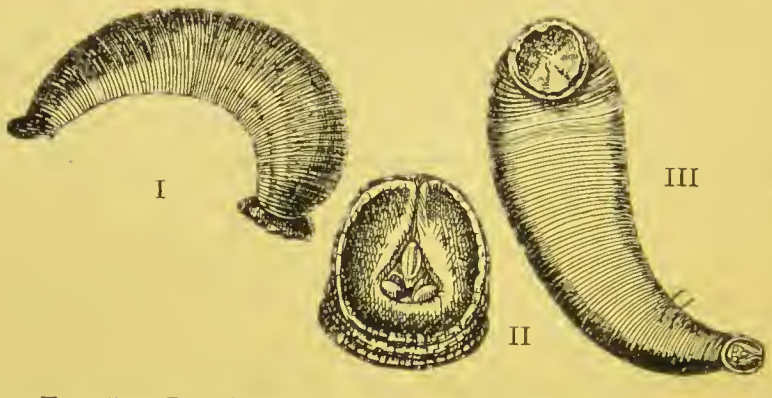


Fig. 58.—I. *Limnatis nilotica*, side view. II. Oral sucker, showing the characteristic median dorsal slit and the three teeth; III. ventral view. (From Savigny.)

Africa until it reaches Egypt, Palestine, Syria, Armenia, and Turkestan, where it achieves its uttermost eastern boundary. This leech lives in stagnant water; especially does it congregate in drinking-wells—the wells so often mentioned in the New Testament. In the Talmud (Abōdāh Zārāh, 17*b*) an especial warning is given against drinking water from the rivers or wells or pools for fear of swallowing

leeches. Doubtless the New Testament Jew knew in his day almost as much as we know now about these leeches. They were the cause of endless trouble to Napoleon's soldiers in his Egyptian campaign, and are still a real pest in the Near East.

I cannot recall that Napoleon talked much about spreading 'Kultur,'[1] but he certainly did it. He took with his army into Egypt a score of the ablest men of science he could gather together in France. He established in Cairo an 'Institut' modelled on that of Paris, and his scientific 'corps' produced a series of monographs on Egyptian antiquities and on the natural history of Egypt that has not yet been equalled by any other invading force. Napoleon freed the serfs in Germany, he codified the laws of France, and these laws were adopted by large parts of Europe, he extended the use of the decimal system. Napoleon had a constructive policy, and was never a consistent apostle of wanton destruction. If he destroyed it was to build up again, and in many instances he 'builded better than he knew.' He seldom so mistook his enemies as to destroy, to terrify; the 'frightfulness,'

[1] I wonder if it is *any* use pointing out that the German word *Kultur* is not the equivalent—as our daily Press takes it to be—of the English word 'Culture,' brought into fashion forty years ago by Matthew Arnold, and from that time sadly overworked. Put shortly *Kultur* = 'civilisation.' The German word which we associate with 'Culture' is *Bildung*.

though bad enough in his times, had limits. Napoleon had at least in him the elements of a sane and common-sense psychology. He knew that what was ' frightful ' to the French was not necessarily ' frightful ' to the Russian.

Amongst the wonderful series of books and monographs on Egypt which described the varying activities of the savants he took in his train, and who, at the confines of the eighteenth and nineteenth centuries invaded the country of the Pharaohs, none is more remarkable than Savigny's monograph on the ' Natural History ' of that country. And in this folio the leech (*Limnatis nilotica*) was for the first time fully described and depicted.

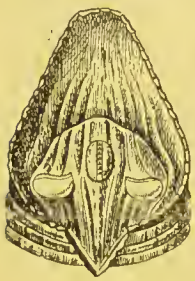


FIG. 59.—Anterior sucker of *Hirudo medicinalis*. This is to compare with the anterior sucker of *Limnatis nilotica*, which has a characteristic dorsal median slit. See preceeding figure. (From Savigny.)

This particular leech is swallowed by man, by domestic cattle, and doubtlessly by wild animals, with their drinking-water. Amongst the medical writers of the Eastern world in classical times who mention leeches there was always, as there was amongst the authors of the Talmud, a great and haunting fear of leeches being swallowed, and these writers mostly wrote from the area where *Limnatis nilotica* still abounds.

According to Mr. Masterman, who has had, as a medical officer in Palestine, a first-hand opportunity of studying this leech, the pest attaches itself to the mouth or throat or larynx during the process of swallowing, and he is convinced that if it be once really swallowed and reaches the stomach it is killed and digested.

Limnatis nilotica, unlike *Hirudo medicinalis* the medicinal leech, is unable to bite through the outer integument of man and is only able to feed when it has access to the softer mucous membrane of the mouth or of the pharynx or of the larynx, and of the other thinner and more vascular internal mucous linings.

In Palestine these pests are particularly common in the region of Galilee and in the district of Lebanon. They are, in these and other districts, so plentiful in the autumn that almost every mule and almost every horse the tourist comes across is bleeding from its mouth or from its nose, for this species of leech is by no means only a human parasite. The natives, who know quite a lot about these pests, generally strain them out of their drinking-water by running the water through a piece of muslin or some such sieve when they fill their pitchers at the common well. In certain districts these leeches in the local pools or reservoirs are kept in check by a fish—a species of carp (*Capöeta fratercula*).

In the cases which recently came under Mr. Masterman's observation, the leeches were attached to the epiglottis, the nasal cavities, and perhaps most commonly of all to the larynx of their host. When they have been attached to the anterior part of the mouth, or any other easily accessible position, their host or their host's friends naturally remove them, and such cases do not come to the hospital for treatment.

The effect of the presence of this leech (*L. nilotica*) on the human being is to produce constant small haemorrhages from the mouth or nose. This haemorrhage, when the leech is ensconced far within the buccal, the nasal, or the pharyngeal passages of the host, may be prolonged, serious, and even fatal. Masterman records two cases under his own observation which ended in death : one of a man and the other of a young girl, both of whom died of anaemia produced by these leeches.

The average patients certainly suffer. They show marked distress, usually accompanied by a complete or partial loss of voice ; but all the symptoms disappear, and at once, on the removal of the semi-parasite. Sometimes the leeches are attached so closely to the vocal cords that their bodies flop in and out of the vocal aperture with each act of expiration and inspiration. The hosts

of leeches so situated usually suffer from dyspnoea, and at times were hardly able to breathe.

The native treatment is to remove the leech, when accessible, by transfixing it with a sharp thorn; or they dislodge it by touching it with the so-called 'nicotine' which accumulates in tobacco-pipes. But nicotine is destroyed at the temperature of a lighted pipe, so whatever the really efficient juice is, it is not nicotine. Still, as long as the fluid proves efficient, the native is hardly likely to worry about its accurate chemical formula.

Masterman says that the treatment he has found most effective were: (1) Seizing the leech, when accessible, with suitable forceps; or (2) paralysing the leech with cocaine. In the former case the surgeon is materially assisted by spraying the leech with cocaine, which partially paralyses it and puts it out of action. In the latter case, if the spraying of cocaine is not sufficient, Masterman recommends the application of a small piece of cotton-wool dipped in 30 per cent. cocaine solution, which must be brought into actual contact with the leech's body. The effect of the cocaine in contact with the skin of the leech is to paralyse the leech and to cause it to relax its hold In such a case the leech is occasionally swallowed, but it is more often

coughed up and out. Headaches and a tendency to vomit are symptoms associated with the presence of this creature in the human body; the removal of the leech or leeches coincides with the cessation of these symptoms.

In the Far East, where many of our Territorial regiments are now stationed, we come across another species of leech even more injurious to mankind than *Limnatis nilotica*. This Asiatic leech is known as *Haemadipsa zeylanica*, and is one of a considerable number of leeches which have left the water, their natural habitat, and have taken to live on land.

Fig. 60.—The Japanese variety of *Haemadipsa zeylanica*. × 1. (From Whitman.)

From India and Ceylon, throughout Burma, Cochin China, Formosa to Japan, the Philippines, and the Sunda Island, this terrible, and at certain elevations ubiquitous, pest is spread. It lives upon damp and moist earth. The family to which it belongs is essentially a family which dwells in the uplands and shuns the hot, low-lying plains. Its members do not occur on the warm, dry, sandy flats. Tennant has described the intolerable nuisance they are in Ceylon. In fact of the many visible plagues of tropical Asia and its eastern islands they are perhaps the worst. Yet few have

recorded their dread doings, and those few have escaped credence.

Each specimen of *Haemadipsa zeylanica* is of a clear brown colour with a yellow stripe on each side and with a greenish dorsal stripe. There are five pairs of eyes, of which the first four occupy contiguous rings; but between the fifth and seventh ring there are two eyeless rings interposed. As in the medicinal leech there are three teeth, each serrated like a saw.

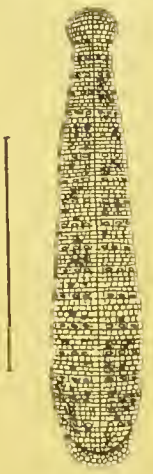


FIG. 61.—*Haemadipsa zeylanica*, seen from above. × 2. (From Blanchard.)

In dry weather they miraculously disappear, and nobody seems to know quite what becomes of them; but with returning showers they are found again on the soil and on the lower vegetation in enormous profusion. Each leech is about one inch in length and is about as thick as a knitting-needle. But they contract until they attain the diameter of a quill pen, or extend their bodies until they have doubled their normal length. They are the most insinuating of creatures, and can force their way through the interstices of the tightest laced boot, or between the folds of the most closely wound puttee. Making their tortuous way towards

the human skin, they wriggle about under the underclothing until they attain almost any position on the body they wish to take up. Their bite is absolutely painless, and it is usual for the human sufferer to become aware that he has been bitten by these silent and tireless leeches when he notices sundry streams of blood running down his body when he at last has the opportunity of undressing.

FIG. 62. — *Haemadipsa zeylanica*. A, head, showing the eyes. B, the serrations of the jaw. Highly magnified. (From Tennant.)

Sometimes, as Tennant's figure shows, these land-leeches (*H. zeylanica*) rest upon the ground. At other times they ascend the leaves of herbs and grasses, and especially the twigs of the forest undergrowth. Perched upon the ends of growing shoots, leaves, and twigs, stretching their quivering bodies into the void, they eagerly watch and wait the approach of some travelling mammal. They easily 'scent' their prey, and on its approach advance upon it with surprising rapidity in semicircular loops. A whole and vast colony of land-leeches is set in motion without a moment's delay, and thus it comes about that the last of a travelling or prospecting party in a land-leech area invariably fares the worst, as these land-leeches mobilise

and congregate with extraordinary rapidity when once they are warned of the approach of a possible host, but not always in time to engage in numbers the advanced guard.

Horses are driven wild by them, and have poor means of reprisal. They stamp their hoofs violently on the ground in the hope of ridding their fetlocks of these tangled masses of bloody tassels. The bare legs of the natives, who carry palanquins, are par-

FIG. 63.—*Haemadipsa zeylanica* (land-leeches), on the earth. (From Tennant.)

ticularly subject to the bites of these blood-thirsty brutes, as the palanquin-bearer has no free hand to pick them off. Tennant writes that he has actually seen the blood welling over the boots of a European from the innumerable bites of these land-leeches; and it is on record that during the march of the troops in Ceylon, when the Kandyans were in rebellion, many of the Madras sepoys, and their coolies, perished from their innumerable and united attacks. It is also certain that men falling asleep over-night

in a Cingalese forest have, so to speak, 'woke up dead' next morning. These sleepers have succumbed during the night to the repeated attacks of these intolerable and insatiable pests.

Dr. Charles Hose, for many years Resident at Sarawak, has told me that on approaching the edges of woods in Borneo you can hear every leaf rustling, and this is due to the fact that the eager leech, perched on its posterior sucker on the edge of each leaf in the undergrowth, is swaying its body up and down, yearning with an 'unutterable yearning,' to get at the integument of man or some other mammal.

Landor, who wrote, I think, the best book about our adventure into Thibet some ten years ago, entitled 'Lhassa' (London, 1905), says of Sikkim :—

> The game here is very scanty: the reason is not uninteresting. For dormant or active, visible or invisible, the curse of Sikkim waits for its warm-blooded visitor. The leeches of these lovely valleys have been described again and again by travellers. Unfortunately the description, however true in every particular, has, as a rule, but wrecked the reputation of the chronicler. Englishmen cannot understand these pests of the mountain-side, which appear in March, and exist, like black threads fringing every leaf, till September kills them in myriad millions.

To remove them a bowl of warm milk at the

cow's nose, a little slip-knot, and a quick hand are all that is required. Fourteen or fifteen successively have been thus taken from the nostrils of one unfortunate heifer.

When fully fed, a process which takes some time with *Haemadipsa zeylanica*, the individual leeches drop off; and they can be made to loosen their hold by the application of a solution of salt or of weak acid. Attempts to pull them off should be avoided, as parts of the biting apparatus are then often left in the wound, and these may cause inflammation and suppuration. Dr. R. J. Drummond, who has had experience of these land-leeches in Ceylon, has told me that the bite is often septic and that it often leads to a serious abscess which is long in healing. He recommends pushing a match, which has been dipped into carbolic acid, well home into the sinus made by the leech's head.

When winter approaches the leeches die down with extraordinary rapidity, and although there is some evidence that a few specimens hibernate the species, as a rule, 'carry on' over the cold-weather period in the form of eggs laid in cocoons on the ground, under leaves, or other débris. Hence very few land-leeches ever see their offspring, and very few land-leeches have ever known a mother's care.

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